

UNIVERSITY OF ADEN. FACULTY OF MEDICINE AND HEALTH SCIENCES
DEPARTMENT OF MORPHOLOGICAL SCIENCES
HUMAN ANATOMY I FOR MEDICAL STUDENTS

SKELETON of the HEAD

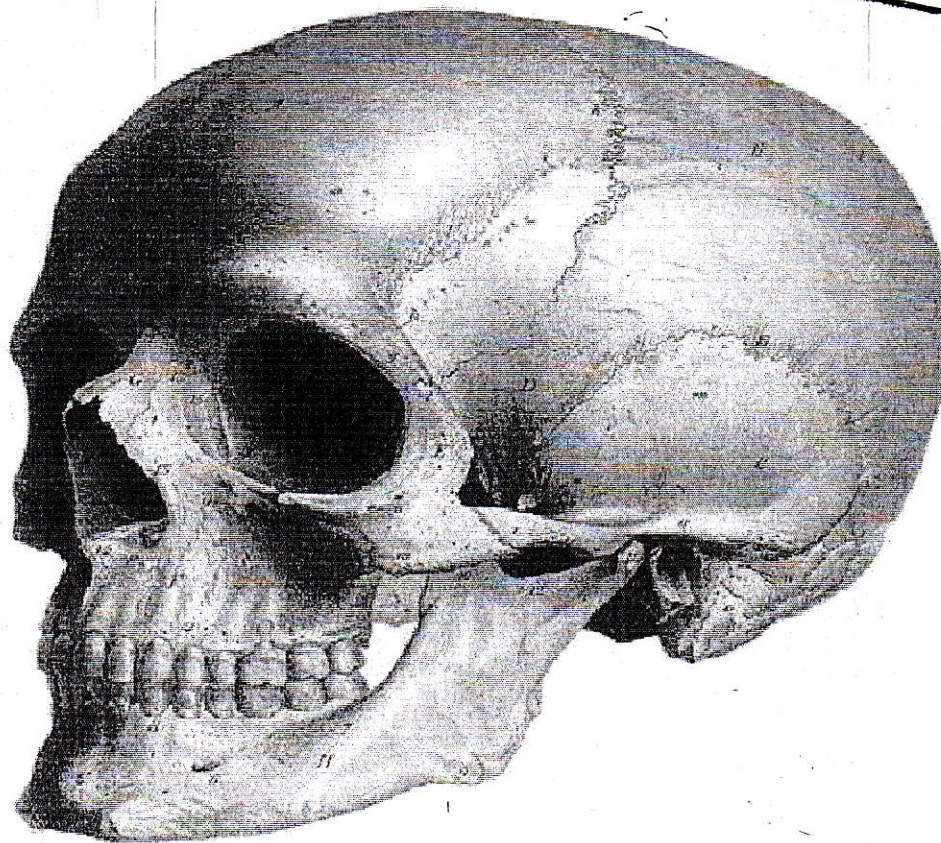
Part II: SKULL as a WHOLE

(Lecture 6)

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parietal bone

Sphenoid bone

Temporal bone

Occipital bone

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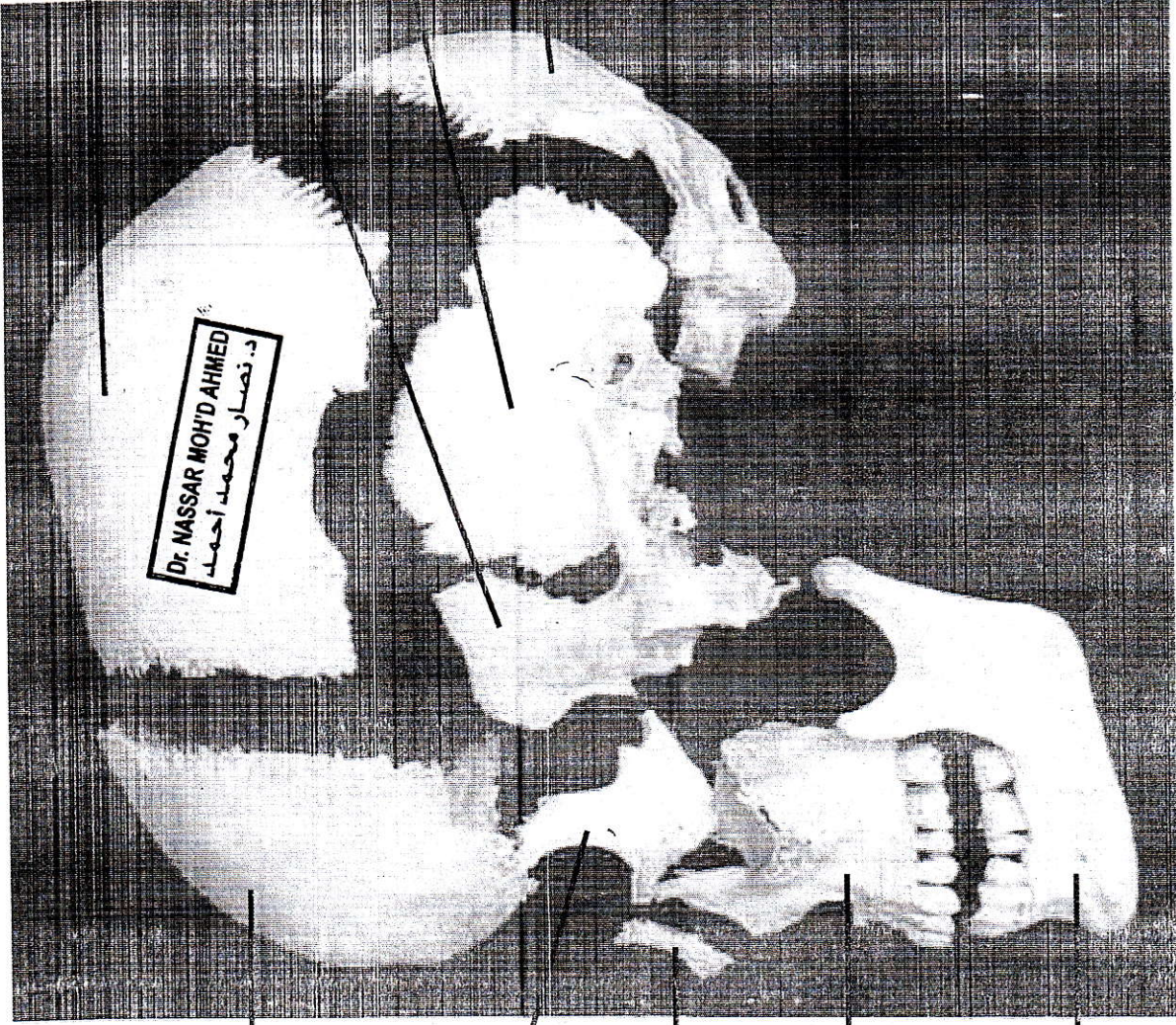
Frontal bone

Zygomatic bone

Nasal bone

Maxilla

Mandible



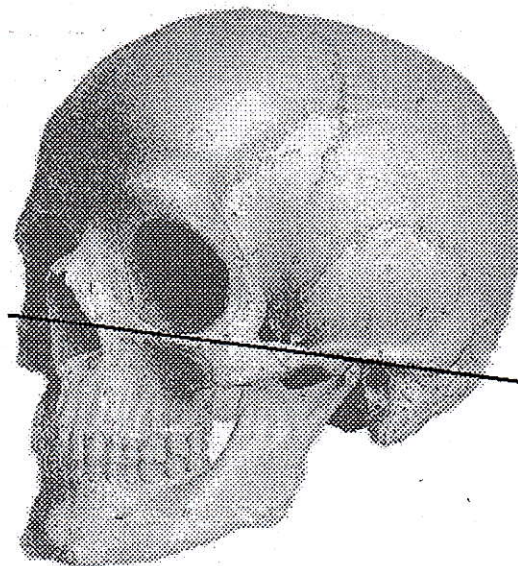
SUMMARY:

1. External view: Exocranium. Normae:
 - a) Norma frontalis. Piriform aperture. Orbit.
 - b) Norma occipitalis.
 - c) Norma verticalis.
 - d) Norma basalis. Parts: anterior, middle, posterior.
 - e) Norma lateralis. Temporal fossa. Infratemporal fossa. Pterigopalatine fossa
2. Internal view: Endocranium.
 - a) Horizontal section. Cranial base: cranial fossa: anterior, middle and posterior. Internal surface of the calvaria.
 - b) Sagittal section. Bony structure of the nasal cavity. Paranasal sinuses. Openings.
3. Joints of the skull: sutures, synchondroses and the synovial temporomandibular joint.
4. Age changes in the skull.. Ossification of the skull. Sex differences



After study the individual bones of the skull, we start now the study of the skull as a whole: that is, with all bones articulated together. This approaching is of great applied value for daily medical practice.

For purposes of description or measurements, the skull is orientated in a standard position with the lower border of the orbit and the upper border of the external acoustic meatus in a horizontal plane. This is known as the Frankfurt plane (the coronal and sagittal planes are at right angles to it), used to orientate the skull in obtaining the normae.



EXTERNAL VIEW OF THE SKULL: EXOCRANIUM

The skull from above: NORMA VERTICALIS

We can see most of the two parietal bones, the squamous part of frontal and nasal bones forwards and only a small part of the occipital squamous backwards. And the sutures between them:

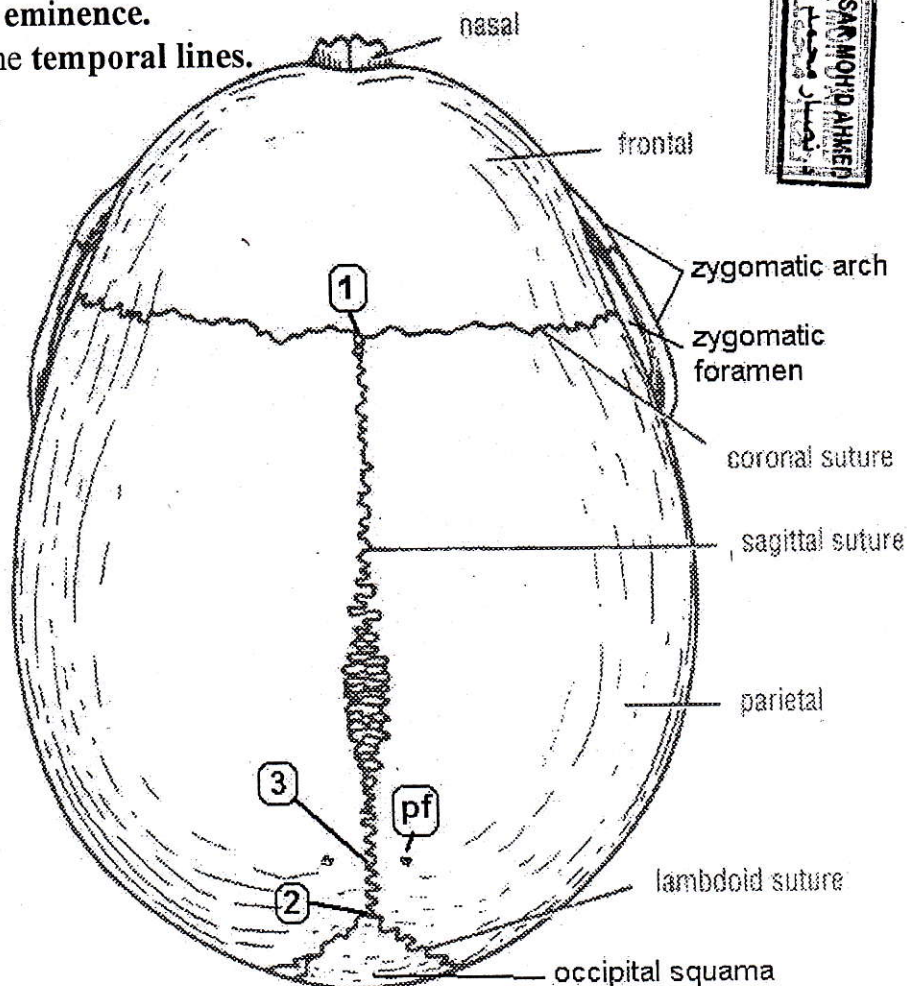
- **Coronal suture:** between parietal bones and frontal squama.
- **Sagittal sutures:** between upper borders of both parietal bones.
- **Lamboid suture:** between parietal bones and occipital squama.

Also we should identify important points like:

1. *Bregma*: meeting point between coronal and sagittal sutures.
2. *Lambda*: meeting point between lamboid and sagittal sutures.
3. *Obelion*: point of the sagittal suture between **parietal foramina (pf)**. It is considered the 'pineal point' (cranial surface projection of the pineal body or gland).

And it is possible to observe other important details:

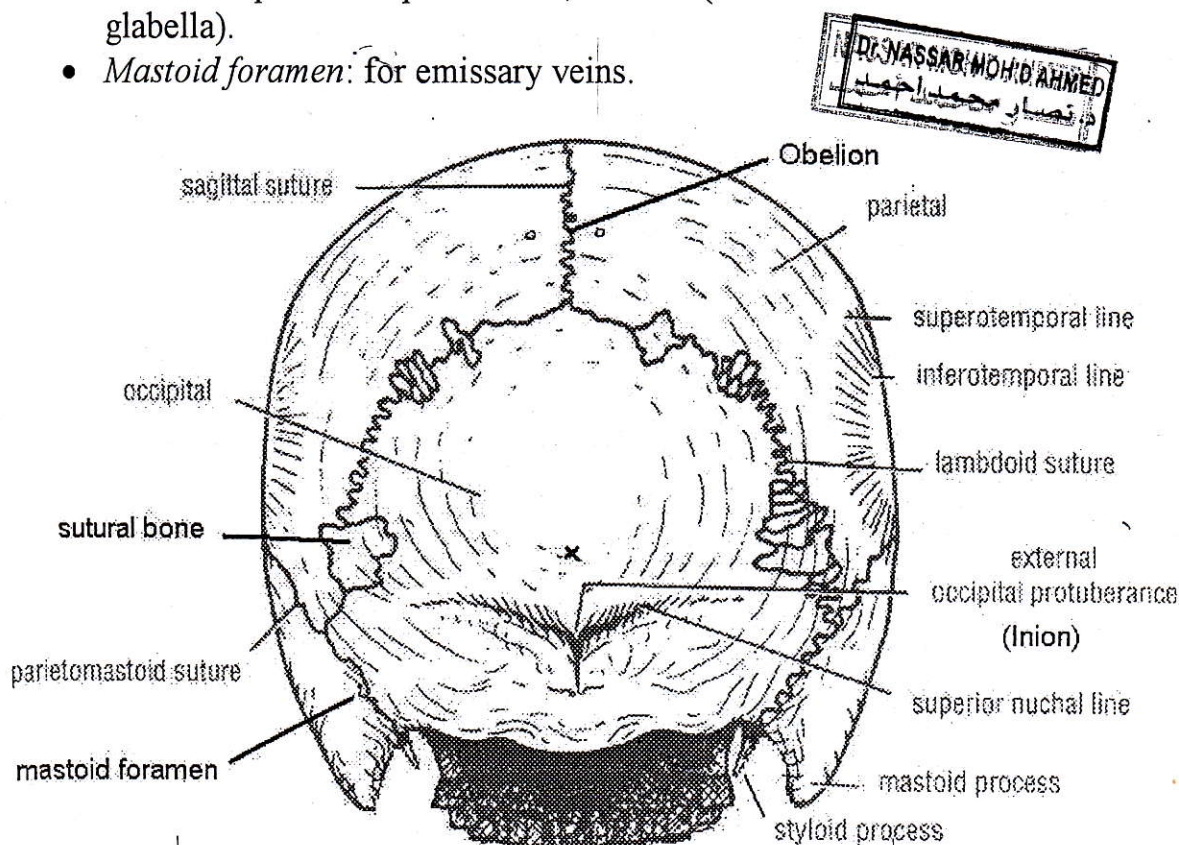
- **Zygomatic arch:** bony structure formed by the temporal process of the zygomatic bone and the zygomatic process of the temporal bone, bounding the **zygomatic foramen**.
- **Parietal eminence.**
- Part of the **temporal lines.**



The skull from behind: NORMA OCCIPITALIS

We can describe it with or without mandible. In the second case you can see the **squamous** part of **occipital** bone separated by the **lambdoid suture** from the posterior border of the **parietal** bones and the **mastoid** region of temporal bones. The most relevant details are:

- *External occipital protuberance*, *external occipital crest* and *the nuchal lines*: *superior nuchal line* is laterally from external occipital protuberance, the *highest* nuchal line is approximately 1cm above the superior nuchal line and the *inferior* nuchal line: laterally from the midpoint of the external occipital crest.
- *Inion*: is the central point of the external occipital protuberance.
- *Occipital point (x)*: median point above the inion, which is the most posterior point of the skull (the furthest from glabella).
- *Mastoid foramen*: for emissary veins.

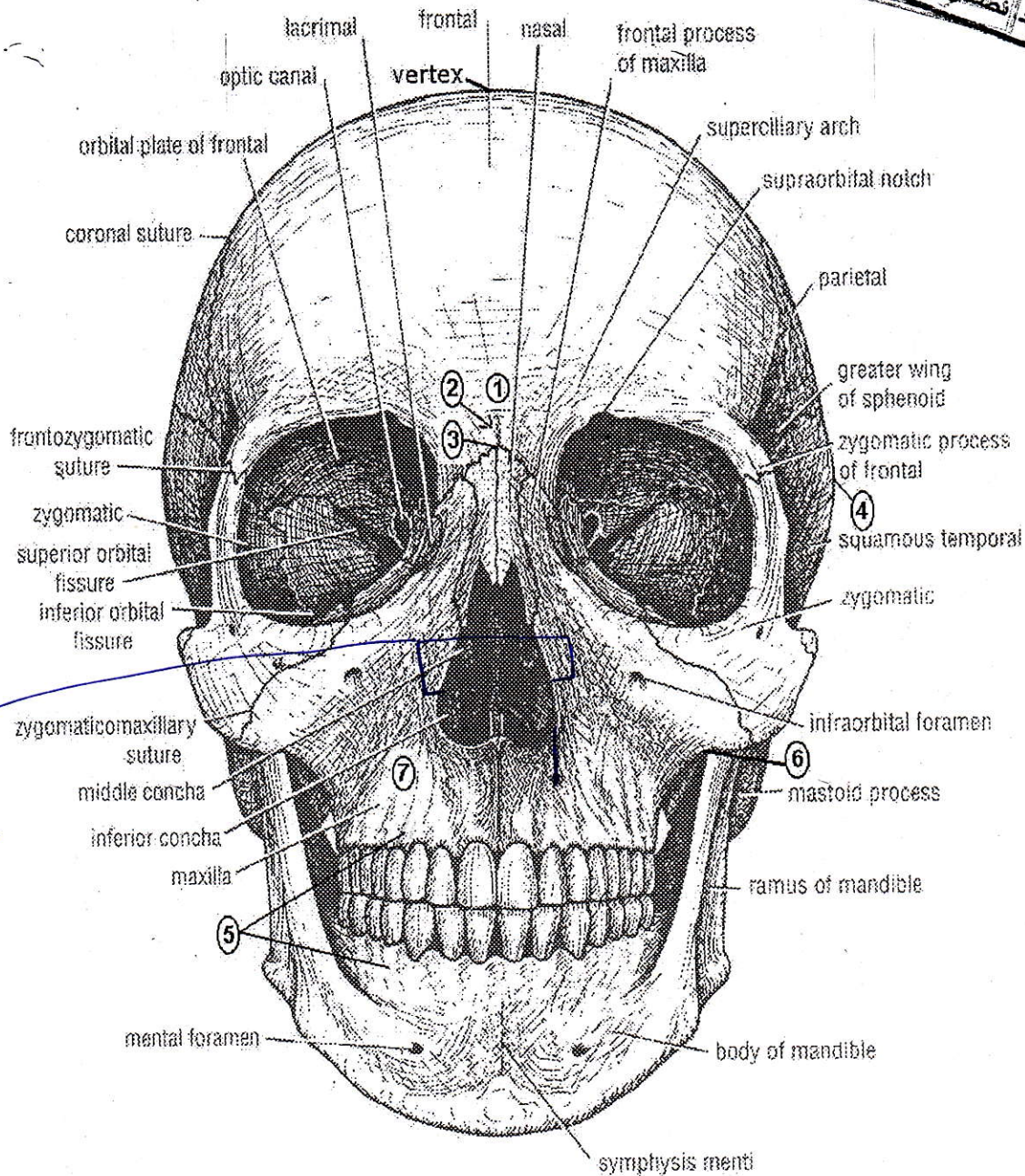


The skull from the front: NORMA FRONTALIS

It is usually described together with the **mandible**, which form the lower third. Above it we can see the **maxillary** bones at both sides of the **piriform aperture** (anterior opening of the nasal cavities in the dry

skull), and laterally the **zigomatic** bones. The upper third is the **squamous** part of the **frontal** bone and below the **orbits** or cavities for the eyeballs. Some important details to identify are:

1. *Glabella*: median elevation between superciliary arches. It is the most anterior point of the cranium.
2. *Metopic suture*: between two halves of frontal bone. Present in about 9% of the skulls.
3. *Nasion*: meeting point between fronto-nasal and internasal sutures.
4. *Eurion*: the most lateral points of the cranium.
5. Upper and lower *alveolar processes*.
6. *Zygomatico-alveolar crest*: reinforcement of the maxillary bone extended along the zygomatic process from the alveolar process.
7. *Canine fossa*: depression above canine eminence.



Piriform
aperture

Description of the ORBITS

The orbits or orbital cavities are two four-sided pyramidal cavities lodging the organ of vision (eyeball). It consists of a **base** anteriorly –**the orbital aditus** or opening- an apex posteromedially –**the optic canal**- and **four walls: superior, inferior, lateral and medial**.

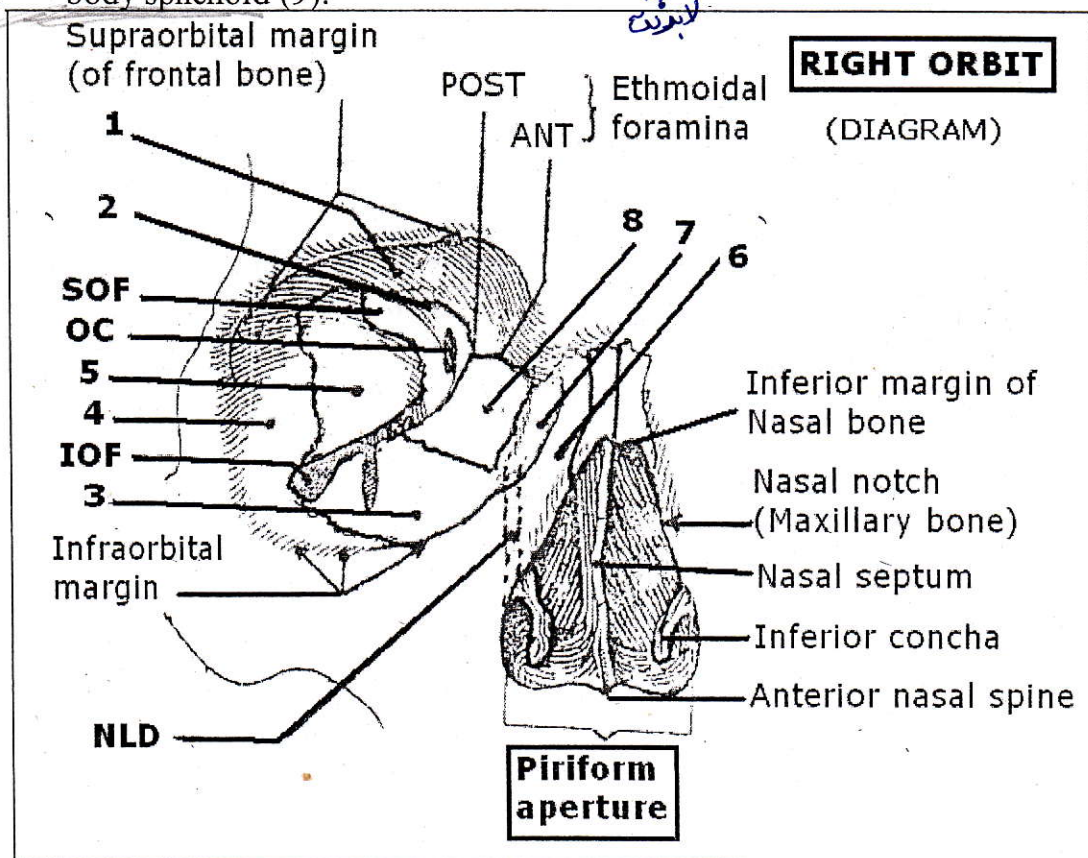
Boundaries of **orbital aditus** or opening:

- Superior: supraorbital margin of frontal bone.
- Inferior: infraorbital margin forming by zygomatic bone laterally and maxillary bone medially.
- Lateral: frontal process of zygomatic bone and zygomatic process of frontal bone.
- Medial: frontal process of maxillary bone (anterior lacrimal crest).

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Walls of the orbit: (→ Use following drawing and fig. of **page 9 & 10**)

- Superior or roof: orbital plate of frontal bone (1), and behind lesser wing of sphenoid (2).
- Inferior or floor: orbital surfaces of maxillary (3) also the orbital process of palatine bone. The **infraorbital sulcus** runs on it.
- Lateral: orbital surfaces of zygomatic bone (4) and of the greater wing of sphenoid (5).
- Medial: lacrimal bone (7), orbital plate of ethmoid bone (8), and body sphenoid (9).



Communications: (→ see previous picture)

- The **superior orbital fissure (SOF)**, which separates the roof and the lateral wall of the orbit, communicates with the middle cranial fossa.
- The **optic canal (OC)** that is the postero-medial apex of the orbit, also communicates with the middle cranial fossa.
- The **inferior orbital fissure (IOF)**, which separates the floor and the lateral wall of the orbit, communicates with the pterigopalatine fossa and the infratemporal fossa.
- The **nasolacrimal duct (NLD)** communicates with the nasal cavity.
- The **ethmoidal foramina** (anterior and posterior) communicate with the anterior cranial fossa.

Description of the PIRIFORM APERTURE



It is the anterior opening of the nasal cavity in the dry skull.

Boundaries: (→ see previous drawing)

- Superior: lower border of the nasal bones.
- Lateral and inferior: nasal notch of the maxillary bones.

The skull from the side: NORMA LATERALIS

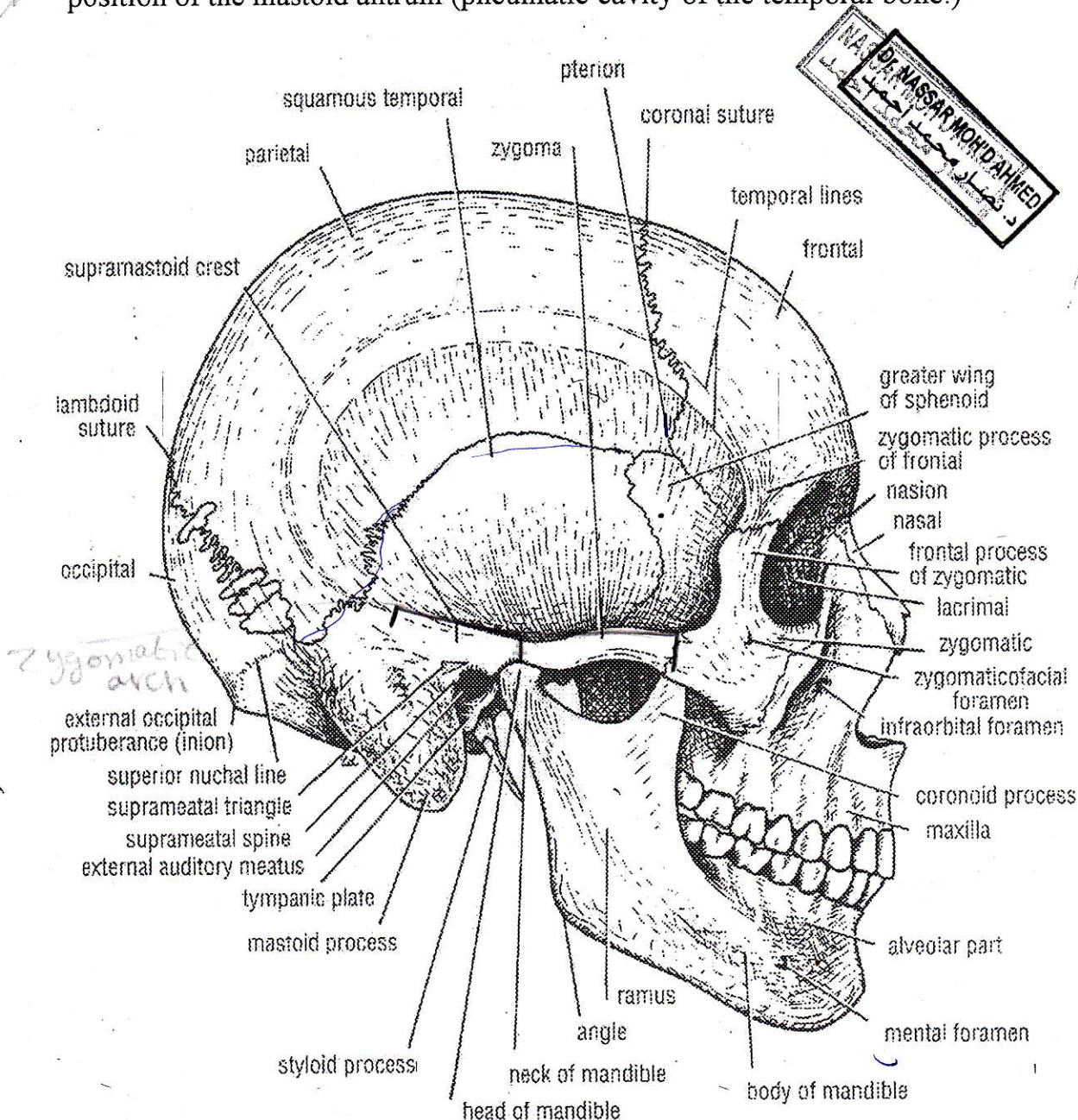
The side view of the skull shows clearly the division into a large, postero-superior, ovoid brain case and a smaller, uneven but almost triangular, antero-inferior facial skeleton attached to it mainly by the zygomatic bone. In this view we can identify and show a number of anatomical features corresponding to independent bones.

Important points in the lateralis norma:

Pterion: H-shaped suture where four bones meet: frontal, parietal, temporal and sphenoid. It is the site of the sphenoidal fontanelle. Its central point is called '**Sylvian point**', lying approximately 4cm above the zygomatic arch and 3cm behind than zygomatic process of the frontal bone. In this region, the anterior (frontal) branch of the middle meningeal artery lies in a groove or tunnel on the interior of the bone and it is liable to be torn in fractures.

Asterion: meeting point of the lamboid, parietomastoid and occipitomastoid sutures. It is the site of the mastoid fontanelle.

Suprameatal triangle: triangular depression below the supra-meatal crest, postero-superior to the external acoustic meatus. It marks the position of the mastoid antrum (pneumatic cavity of the temporal bone.)



Also three fossae are described in the lateralis norma: temporal, infratemporal and pterigopalatine.

Temporal fossa: a wide area enclosed between the superior temporal line above, and the zygomatic arch and the infratemporal crest below.

Walls:

- Anterior: temporal surface of the zygomatic bone.
- Medial: temporal squama, lower part of parietal bone, small part of frontal bone and greater wing of sphenoid.

Communications: it communicates with the infratemporal fossa through the zygomatic foramen, and with orbital cavity through inferior orbital fissure.

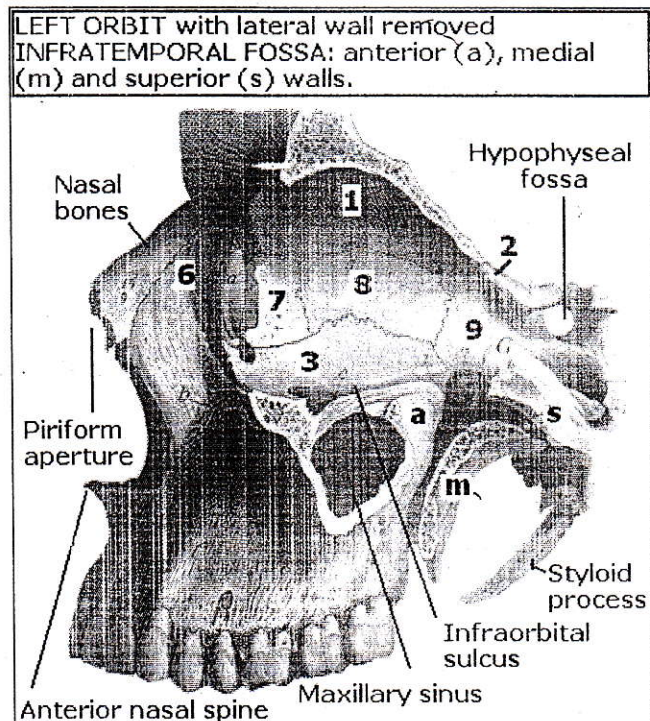
Infratemporal fossa: it is the space situated below the horizontal part of the greater wing of the sphenoid and medially to the ramus of the mandible.

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Walls:

- Superior: horizontal part of the greater wing of sphenoid (s).
- Anterior: posterior surface of the maxillary bone (a).
- Medial: lateral plate of pterygoid process (m).
- Lateral: ramus of the mandible (→ see picture in previous page).

The infratemporal fossa is open posteriorly and inferiorly (no posterior neither inferior walls):



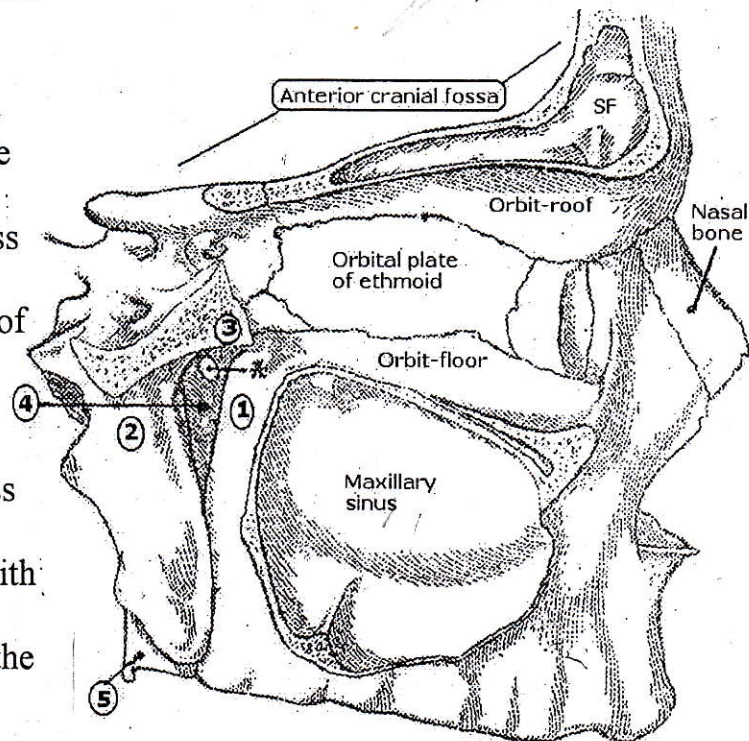
Communications:

- With the pterygopalatine fossa through the **pterygomaxillary fissure**.
- With the orbital cavity through the **inferior orbital fissure**.
- With the middle cranial fossa through the **foramen ovale and spinosum**.
- With the temporal fossa through the zygomatic foramen.

Pterigopalatine fossa: It is a narrow cleft placed deeply below the apex of the orbit.

Walls:

1. Anterior: posterior (infratemporal) surface of the maxillary bone.
 2. Posterior: pterigoid process of sphenoid.
 3. Superior: inferior surface of sphenoid bone.
 4. Medial: vertical plate of palatine bone.
 5. Inferior: pyramidal process of palatine bone. (Here the fossa becomes continuous with the greater palatine canal).
- Lateral: it is open. Here is the pterygomaxillary fissure.



Communication:

- With the nasal cavity through the sphenopalatine foramen (*).
- With the oral cavity through the greater palatine canal.
- With the infratemporal fossa through pterygomaxillary fissure.
- With the orbit through the inferior orbital fissure.
- With the middle cranial fossa through foramen rotundum and the pterigoid canal.



The skull from below: NORMA BASALIS

It is the inferior aspect of the skull after removal of the mandible. For descriptive purpose, it is divided into three parts: **anterior, middle and posterior** by two transverse lines:

- The first is passing through the posterior nasal spine and maxillary tuberosities.
- The second is passing through the anterior margin of the foramen magnum.

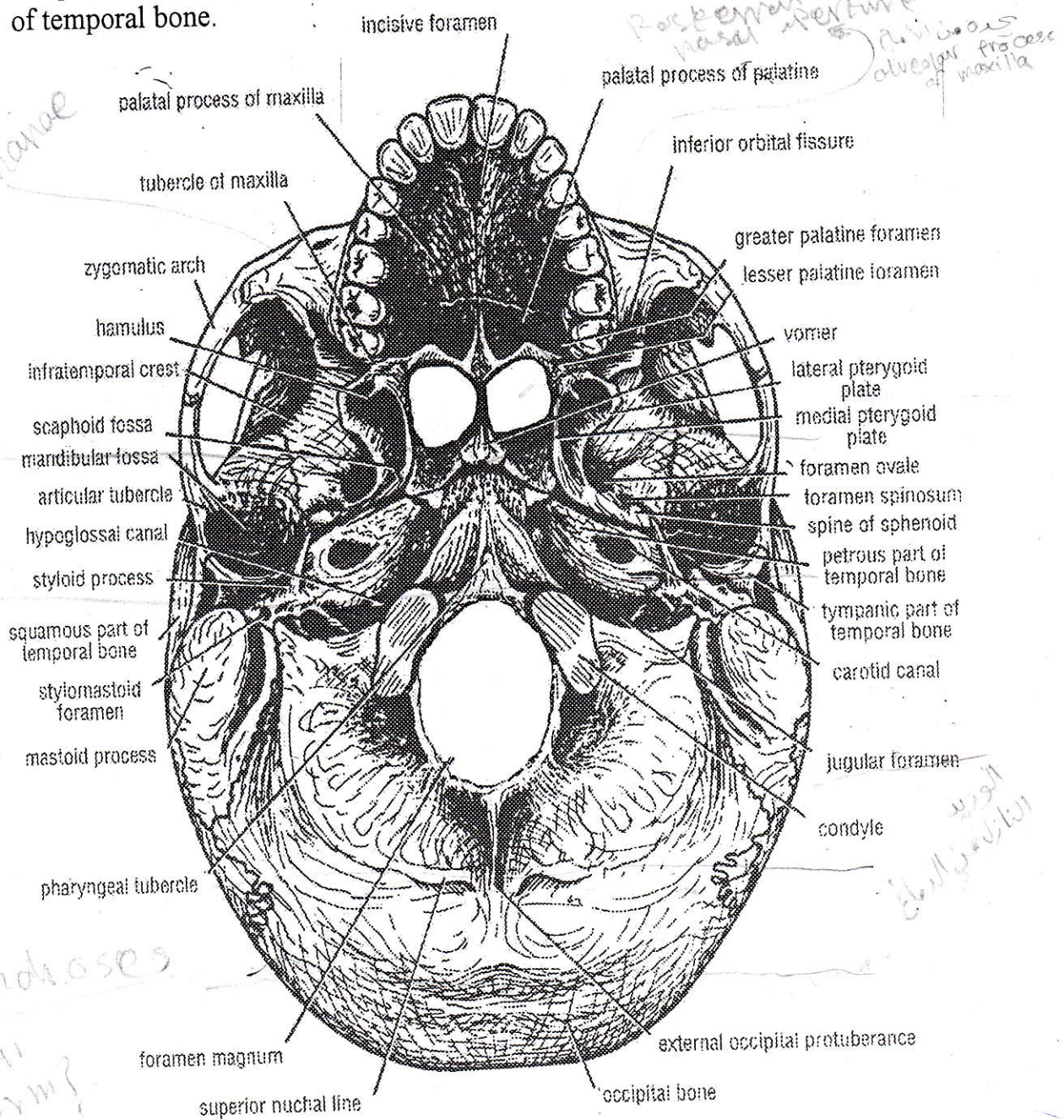
Anterior part: It is mainly formed by the maxilla bone (upper jaw) including the hard palate and the posterior openings of the nasal cavity or choanae, limited by:

- Superiorly: alae of vomer and inferior surface of the body of sphenoid.
- Inferiorly: horizontal plate of palatine bone.
- Laterally: medial plate of pterigoid process of sphenoid.
- Medially: posterior border of vomer.



Middle part: It is a transverse bar of bone formed by the undersurface of: the basilar part of occipital bone, the sphenoid bone and the temporal bone.

Posterior part: Large portion formed by the lateral parts and squama occipital bone (see also description of this bone), and the mastoid process of temporal bone.



the posterior limits of the anterior cranial fossa will be the ~~anterior~~ interior of the middle fossa

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INTERNAL VIEW OF THE SKULL: ENDOCRANIUM

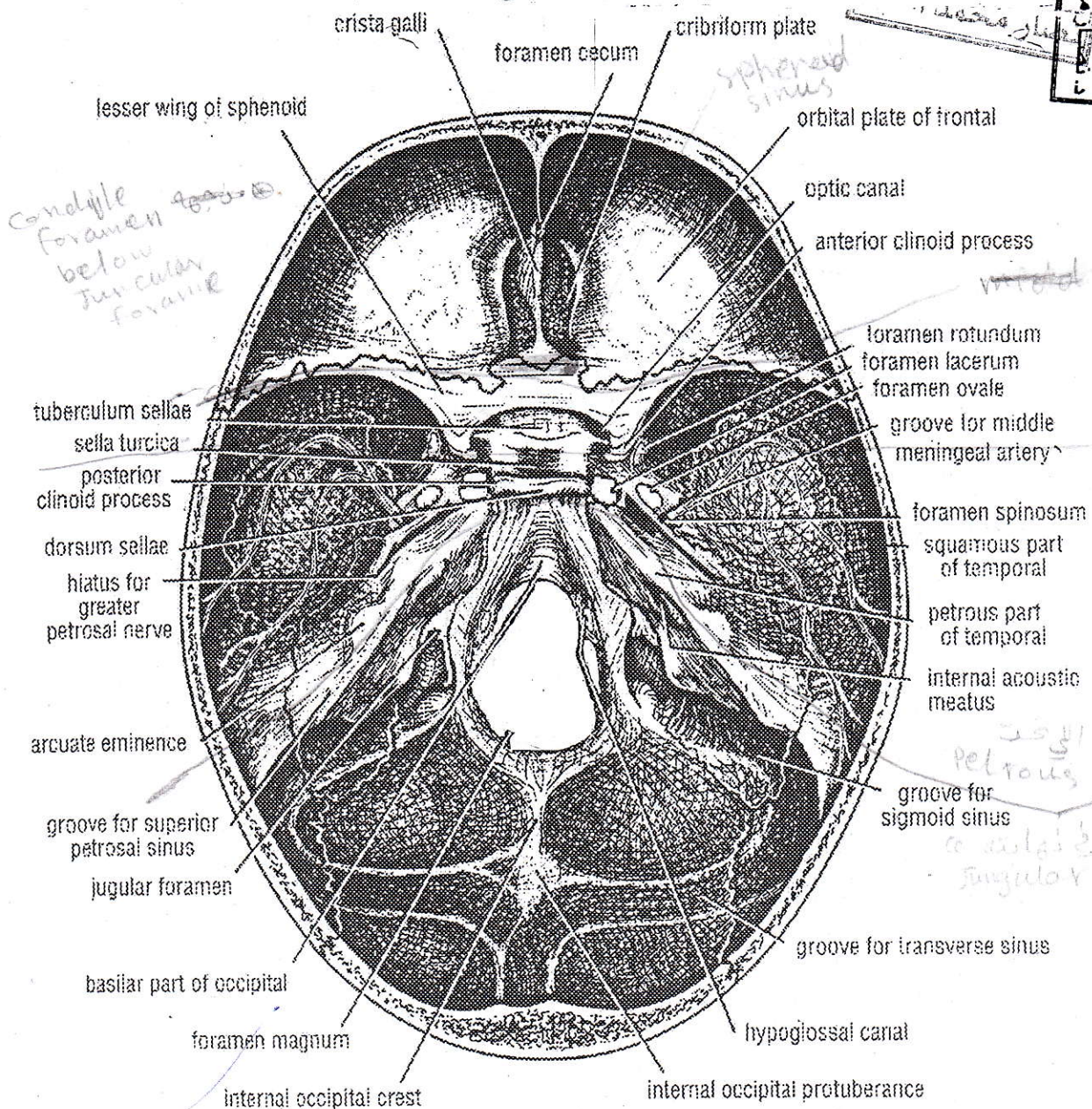
(Cranial fossa)

Inner surface of the cranial base: the floor of the cranial cavity.

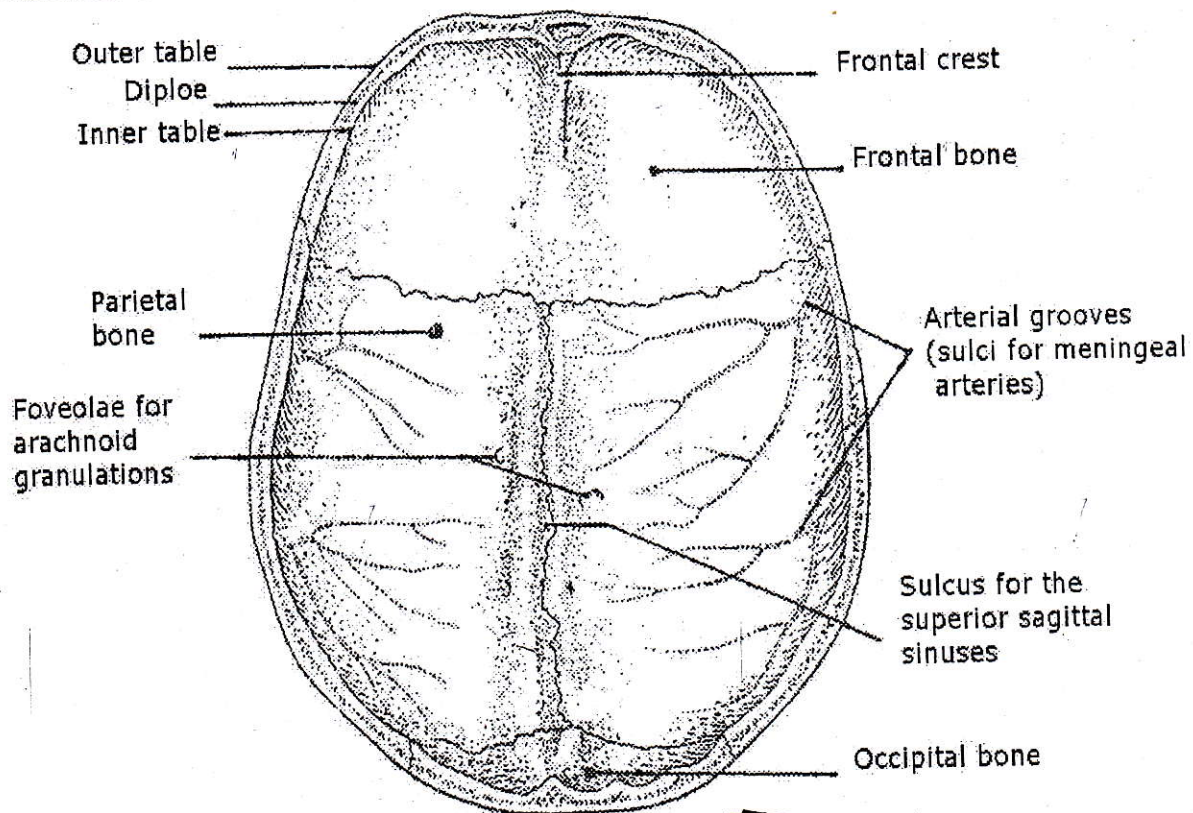
It is divided into three 'cranial fossae':

- **Anterior** cranial fossa: from the squama frontal to the posterior border of the lesser wing and sphenoidal jugum of the sphenoid bone (optic groove or chiasma)
- **Middle** cranial fossa: the posterior border of the lesser wing and sphenoidal jugum of the sphenoid bone or (optic groove or chiasma) to superior borders of the dorsum sella and superior petrosal sulcus of temporal bone.
- **Posterior** cranial fossa: from the dorsum sella and superior petrosal sulcus of temporal bone to internal occipital protuberance and transverse sulcus or groove

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Internal surface of the cranial vault (calvaria)



Sagittal section of the skull



In the sagittal section of the skull we can identify and show the same features studied in other views of inner surface of the cranial cavity and also **the bony structure of the nasal cavity**. The nasal cavity has four walls and two openings.

Walls of the nasal cavity:

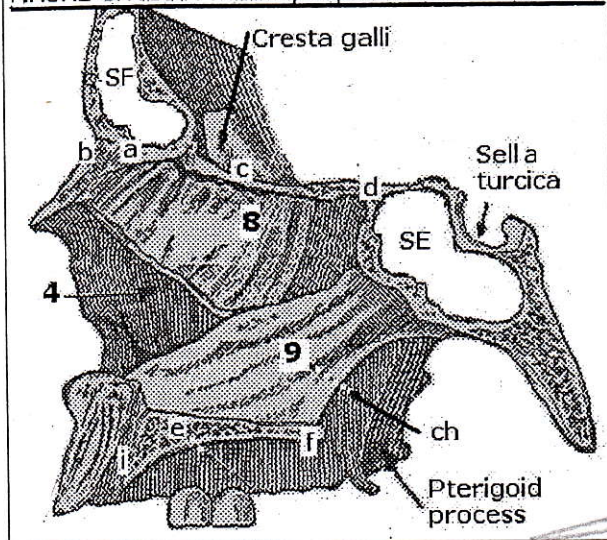
Superior wall or roof: is formed by nasal part of frontal bone (a), nasal bones (b), cribriform (horizontal) plate of ethmoid bone (c) and body of sphenoid (d). (→ See the picture in the following page)

Inferior wall or floor: constitute the **hard palate** and the horizontal plate of palatine (f) and palatine process of maxillary bone (e) forms it. (→ See the picture in the following page)

Medial wall: constitutes the **nasal septum** and the perpendicular plate of ethmoid bone (8) and vomer (9) forms it. In living subjects, the septal

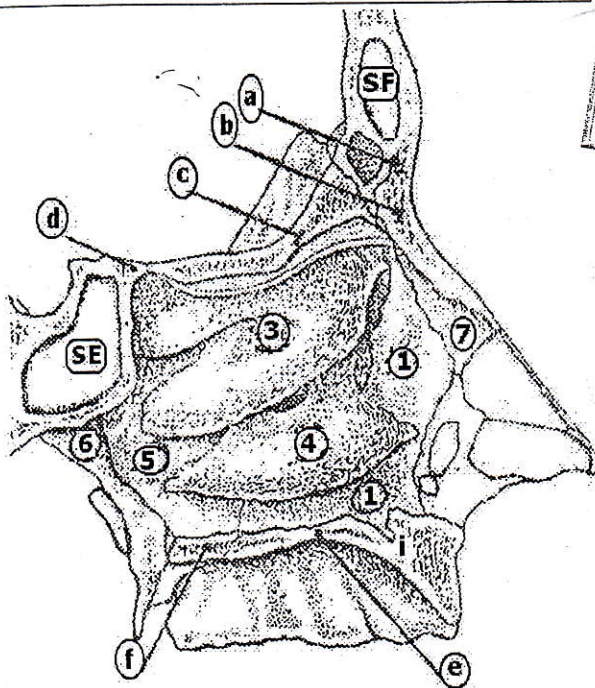
cartilage of the nose completes the nasal septum (→ See the picture in the following-page.)

NASAL CAVITY: medial, superior & inferior walls

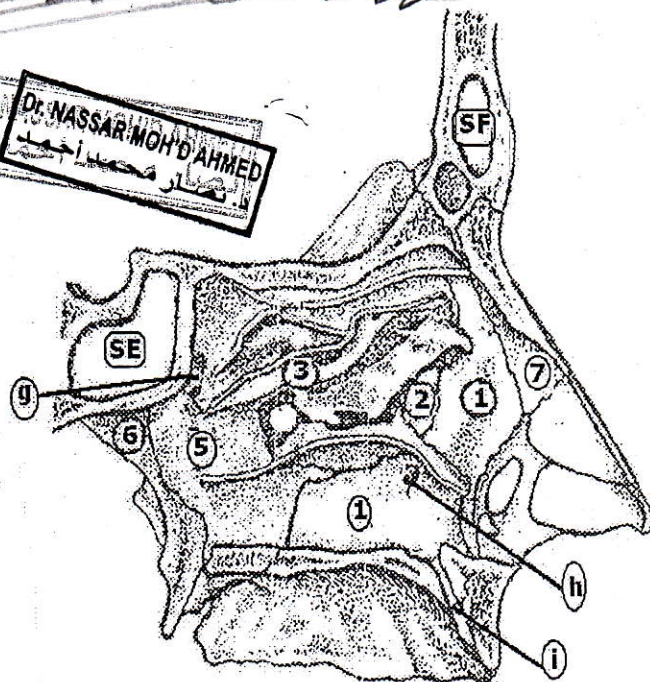


Lateral wall (→ see below): is the most complex because seven bones take part in its formation:

1. Lateral surface of maxillary.
2. Lacrimal bone.
3. Ethmoidal labyrinth.
4. Inferior nasal concha.
5. Perpendicular plate of palatine bone.
6. Medial plate of pterigoid process of sphenoid.
7. Inner surface of nasal bone.



A: With nasal conchae



B: After removal them

Openings of the nasal cavity:

- Anterior or Piriform aperture.
- Posterior or choanae (ch).

Communications of the nasal cavity:

- With the oral cavity through the incisive canals (i).
- With the orbit through the nasolacrimal duct (h). Its opening is in the inferior nasal meatus.
- With pterigopalatine fossa through the sphenopalatine foramen (g).

Paranasal sinuses
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- With the anterior cranial fossa through foramina of the cribriform plate of ethmoid bone.
- With nasopharynx through choanae.

Paranasal sinuses (→ see picture in page 1):

They are air-filled cavities produced by evagination of mucous membrane from the nasal cavity into adjacent skull bones. They serve to lighten what would otherwise be heavy bone. They also act as resonating chambers, which affect the quality of the voice.

- **Frontal sinus (SF)**: within the frontal bone at the junction between the squamous and horizontal parts. It is usually asymmetrical and of variable size and shape.
- **Sphenoidal sinus (SE)**: within the body of sphenoid. It is incompletely divided by a sagittal septum.
- **Ethmoidal air cells**: three groups (anterior, middle and posterior) of small air cells within the ethmoidal labyrinths.
- **Maxillary sinus**: the largest of the Paranasal sinuses within the body of the maxillary bone.

All Paranasal sinuses communicate with the nasal meatus:

In the sphenothmoidal recess:

- Opening of the sphenoidal sinus (1)

In the superior nasal meatus:

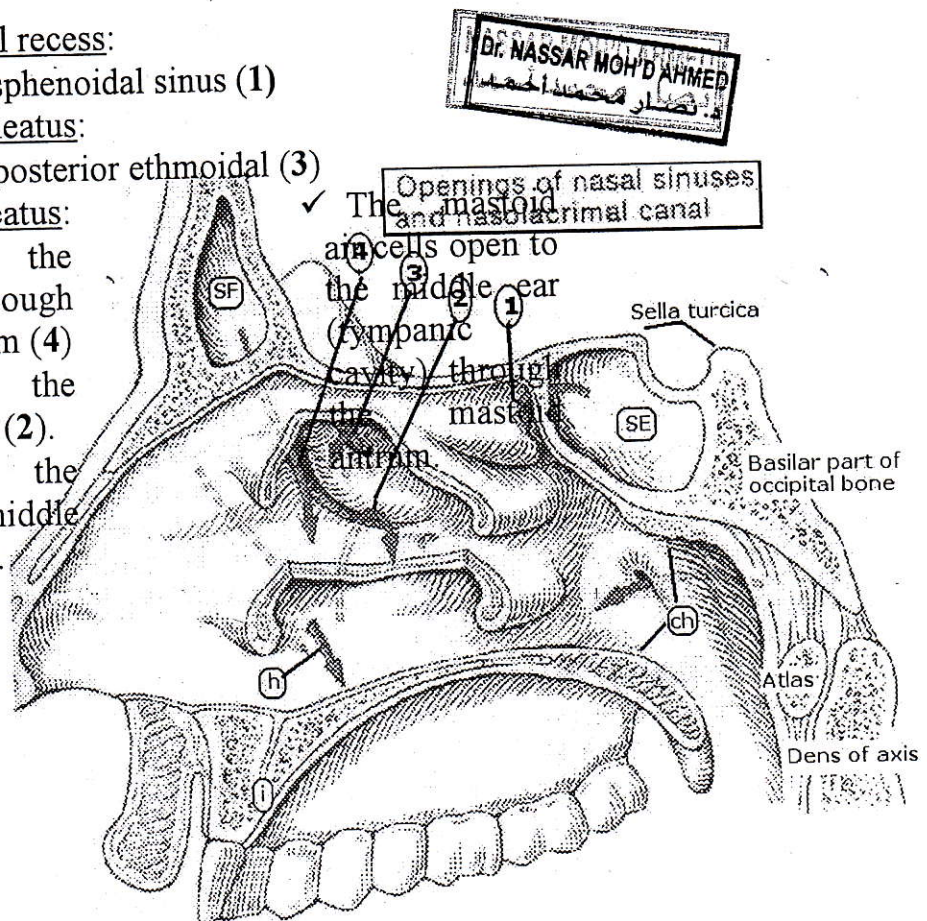
- Opening of the posterior ethmoidal (3)

In the middle nasal meatus:

- Opening of the frontal sinus through the infundibulum (4)
- Opening of the maxillary sinus (2).
- Openings of the anterior and middle ethmoidal cells.

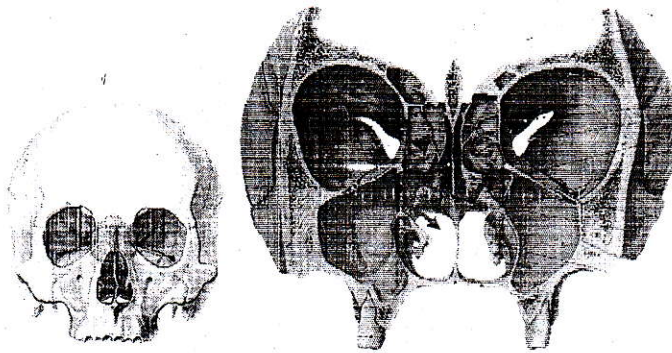
Notes:

- ✓ There is not any sinus opening into inferior nasal meatus.



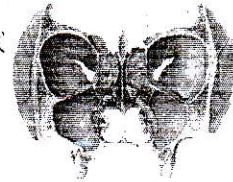
Maxillary sinus

Largest paired sinus, lie in the body of maxilla;
Opening into middle nasal meatus



Ethmoidal cells

Lie in ethmoidal bone,
contains large number of
air cells, divided into
anterior, middle and
posterior groups
Anterior and middle
groups drain into middle
nasal meatus, while
posterior group drains
into superior nasal
meatus



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Sphenoidal sinus

- Lies in body of sphenoid bone
- Drain into sphenoethmoidal recess



JOINTS OF THE SKULL

Most joints between bones of the skull are non-movable (synarthroses), except the temporo-mandibular joint (TMJ).

Sutures are predominant in the adult calvaria (vault) and in the face (→ see them in drawings of the different views of skull):

- **Serrate** sutures are found mainly in the calvaria like coronal (frontoparietal), sagittal (interparietal) and lambdoid (parieto-occipital).
- **Squamous** suture is only the parieto-tempora.
- **Plane** or flat suture are frequent between the facial skeleton bones like inter-nasal, maxillo-zygomatic, forming the hard palate, etc.

Syndesmosis type **fontanelle** or **fonticulus** (picture in page 18) are present between the bones of the calvaria in newborns and during the first months of life (infant period). And to explore them it is necessary in pediatric because they are growth centers.

Cartilaginous joints are present in the skull base and between the portions of a bone having this type of ossification during the age of growth and development. Only some traces of them can be appreciated in a dry skull (see page 12). Then, they are predominantly type **synchondroses**. Two examples are: espheno-occipital and espheno-ethmoidal joints, which play an important role in the antero-posterior growth of the skull base.

The only one synovial joint is TMJ:

It is established between the mandible and the temporal bone, with the presence of an intervening fibro cartilaginous disc between them.

Classification: complex, combined, condylar, multiaxial.

Articular surfaces:

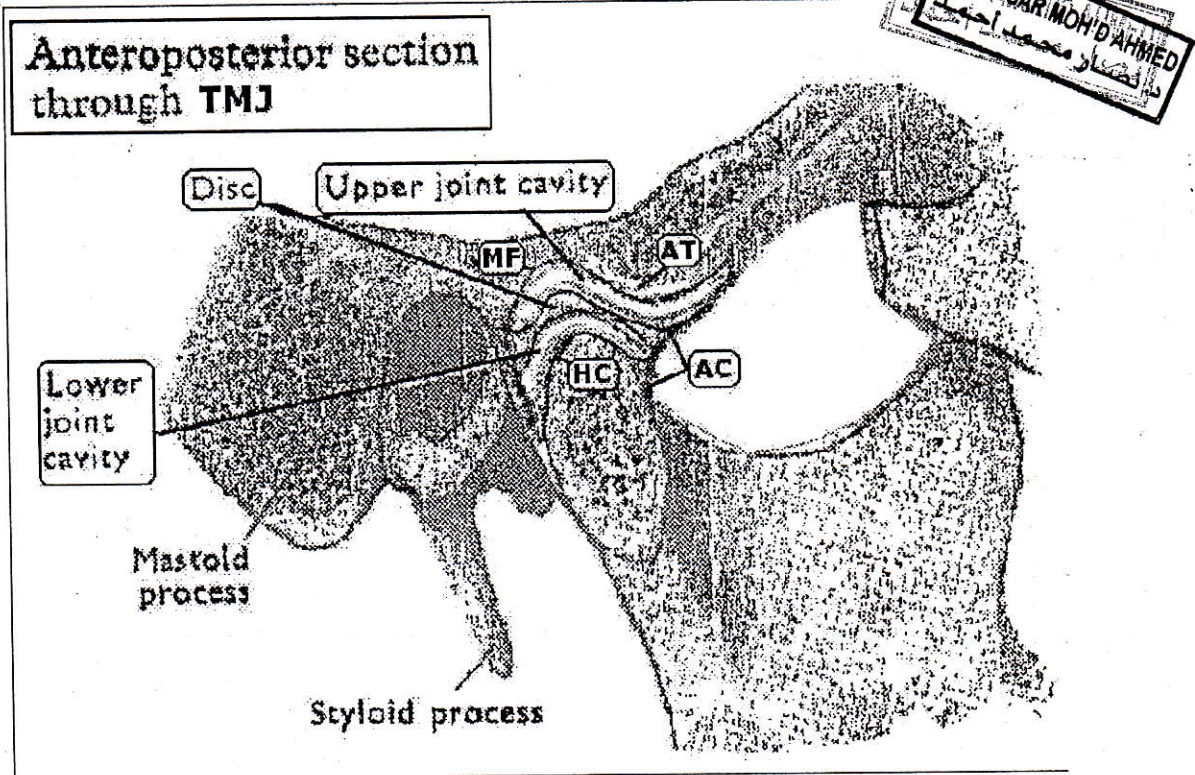
- Upper: mandible fossa (MF) and articular tubercle (AT) of the temporal bone.
- Lower: head of the condylar process of mandible (HC).
- The **intra-articular disc** intervenes between the two bony surfaces and can be considered as providing an additional pair of articular surfaces.



Articular cavity: lined by synovial membrane. It is divided into two compartments by the **disc** and the articular capsule attached around it:

- Upper joint cavity or temporo-disc compartment.
- Lower joint cavity or mandibulo-disc compartment.

Articular capsule (AC): attached above to the limits of the temporal articular surface, and below to the neck of the mandible. Midway, its deepest fibers attach to the margins of the intra-articular disc. A well-defined **lateral ligament** reinforces the articular capsule laterally extending obliquely downwards and backwards from the articular tubercle to the neck of the mandible.



Accessory ligaments: they help to keep in position the mandible.

- Sphenomandibular: extending from spine of the sphenoid to the lingula of mandible.
- Stylomandibular: extending from styloid process to the angle of mandible.

Movements of the T.M.J.:

- Depression or lowering to open the mouth.
- Elevation or rising to close the mouth.
- Protraction or forward movement.
- Retraction or backward movement.

- Lateral displacement.
- Circumduction is also performed during functional masticatory.

Age changes of the skull

The skull at birth:

1. The cranium is relatively large but the face is small (proportions $\rightarrow$ 1:8 in newborn and 1:3 in adult people). This is due to:

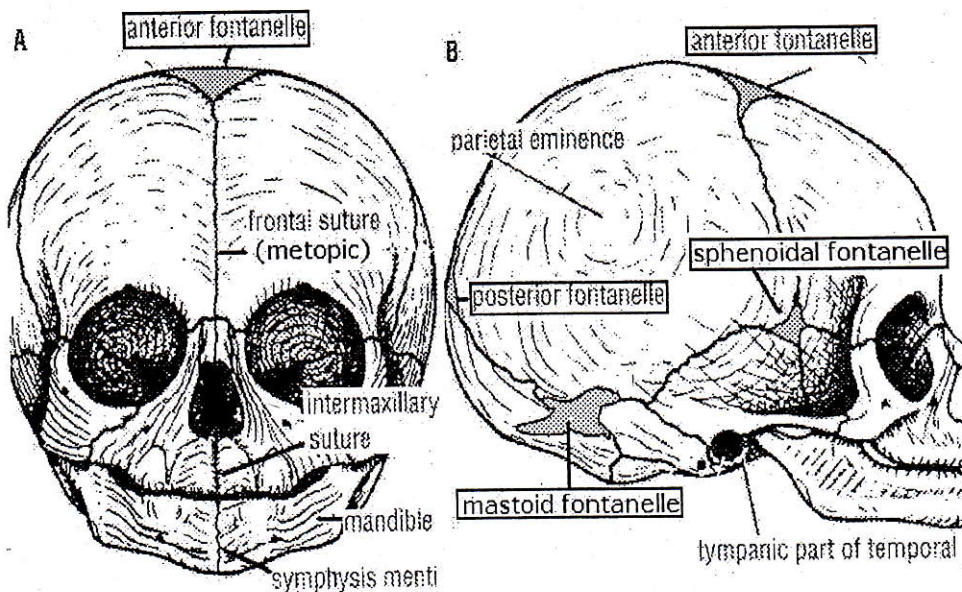
- ✓ The teeth are still non-erupted.
- ✓ The Paranasal sinuses are rudimentary.
- ✓ The jaw and the nasal cavity are small.



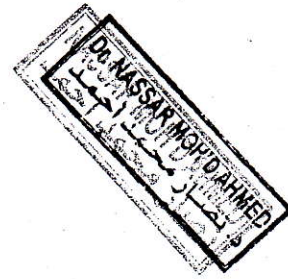
2. Also, strips of fibrous tissue allowing mobility and overlapping during birth separate vault bones, in certain places, large areas remain unossified: they are called **fonticuli or fontanelle**:

- **Anterior or bregmatic fonticulus**: the largest one, placed at Bregma, easily felt in the newborn child. It closes during the second year.
- **Posterior or lamboid fonticulus**: placed at the apex of occipital, between the two parietal bones. It closes two months after birth.
- **Sphenoidal fonticulus**: at the sphenoidal angle of each parietal bone. They close three month after birth.
- **Mastoid fonticulus**: at the mastoid angle of each parietal bone. They close towards the end of first year.

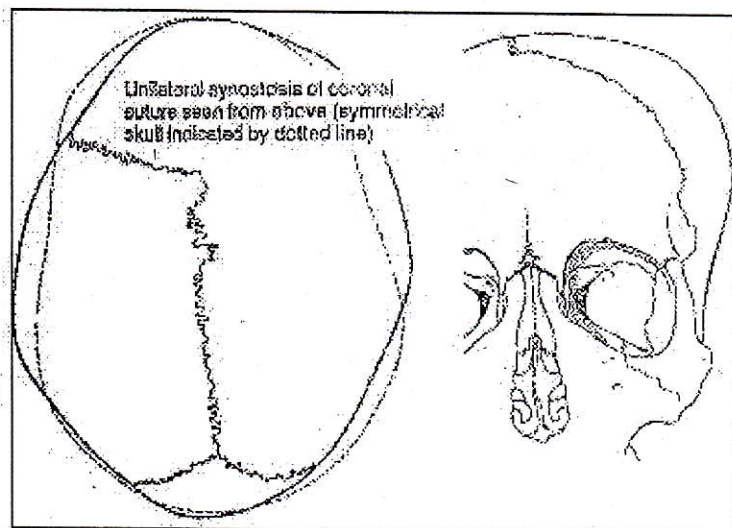
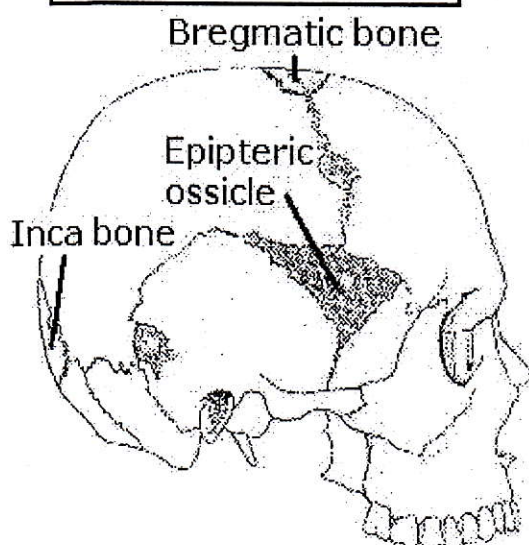
Neonatal skull as seen from the anterior (A) and lateral (B) aspects.



3. The tympanic part of the temporal bone is still only an incomplete tympanic ring so; the acoustic meatus is therefore short.
4. There is not mastoid process in the newborn.
5. The orbits are relatively large.
6. The nasal bones are flat; the bridge of the nose is short.
7. Absence of superciliary arches.
8. At birth, the two halves of the mandible are. They fuse completely in the second year.
9. The angle of the mandible is very wide at birth. By the 4th year is about 140 grades in the old age.
10. The mental foramen is midway between the base and the alveolar process in the adult. In the old age, due to the loss of teeth, the mental foramen is placed towards the upper border.
11. The development of the air (pneumatic) sinuses reaches its maximum stage after puberty.
12. The synchondroses of the cranial base fuse after the 20th year.
13. The obliteration of most sutures starts after childhood. **Sutural bones** may result from independent ossification centers in various sutures and fonticuli. They are usually irregular in size and shape. They are frequent at lamboid suture (→ see picture in page 4). Sutural bones appear in great number in hydrocephalic skulls. Some research works support a genetic factor. Sometimes, some disturbances occur to the ossification process of certain sutures, causing asymmetry and dimorphism of the skull.



SOME SUTURAL BONES



Ossification

Most bones at the cranial base (or parts of bones) develop by cartilaginous (endochondral) ossification: body and lesser wings of the sphenoid, petrous and mastoid parts of the temporal bone; basilar, lateral parts and lower part of the squama of the occipital bone.

Bones of the calvaria are formed by intra-membranous ossification: frontal, greater wings of sphenoid, parietal, temporal squama, upper part of occipital squama.

Other bones, mainly of the face, ossify in membrane overlying cartilage: vomer, lacrimal, nasal, upper part of maxilla, palatine bones, pterigoid process, tympanic plate of temporal bone.

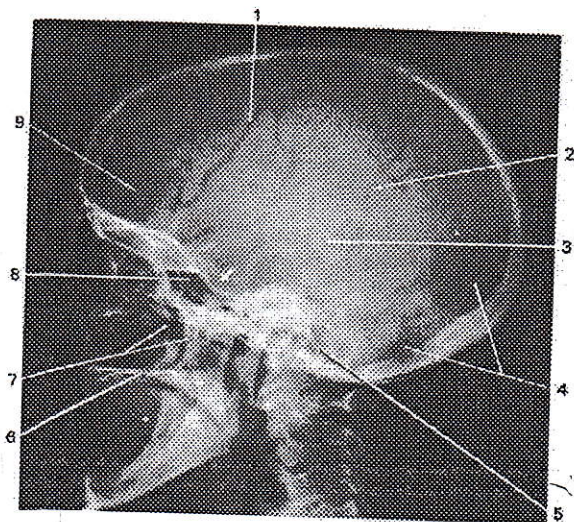
Sex differences of the skull



No single feature or dimension is absolutely reliable to determine the sex of skull. The following are the best seen in most skulls of adult **female** subjects:

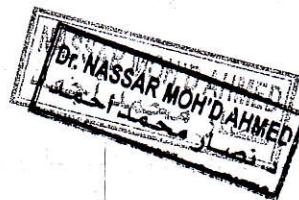
- | | |
|---|---|
| • Lighter | • Small mastoid process |
| • Smoother architecture | • Frontal eminences bulge more. |
| • Less pronounced muscular ridges | • Less prominent superciliary arches |
| • Facial region rounded | • Supraorbital margin sharper |
| • Smaller mandible | • Forehead more vertical |
| • Zygomatic region is lighter and more compressed | • Smaller palate and parabolic in shape |
| • Parietal eminences more convex | • Occipital condyles smaller |
| • Less height of the skull | • Vertex more flattened |

Radiological anatomy

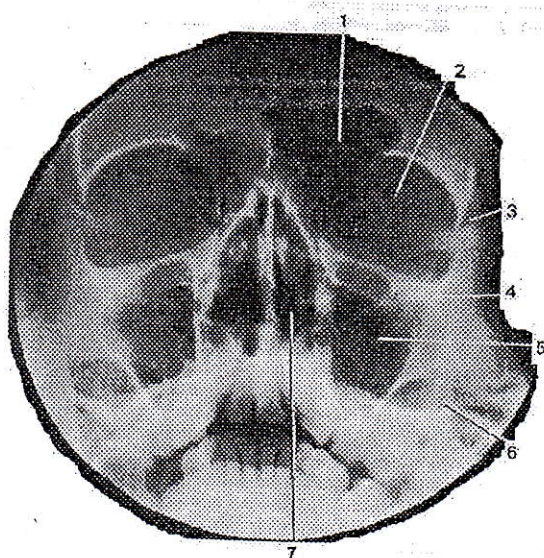
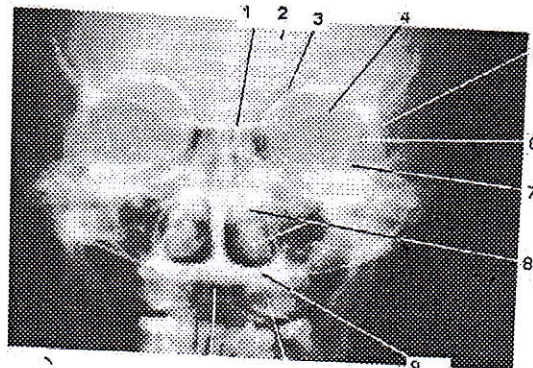


Lateral radiograph (slightly oblique) of adult, edentulous head.

1. Anterior temporal diploic vein.
 2. Posterior temporal diploic vein.
 3. Calcified pineal body.
 4. Thin areas of occipital bone.
 5. Mastoid air cells.
 6. Hard palate.
 7. Posterior walls of maxillary sinuses.
 8. Sphenoidal sinuses.
 9. Frontal diploic vein in thin area of frontal bone.
- (The arrow indicates the sella turcica)



- Postero-anterior radiograph of skull with hard palate horizontal.
1. Central part of floor of anterior cranial fossa.
 2. Margin of frontal sinus.
 3. Extension of frontal sinus into orbital plate of frontal bone.
 4. Lesser wing of sphenoid.
 5. Frontozygomatic suture.
 6. Medial wall of temporal fossa (greater wing of sphenoid).
 7. Petrous temporal bone, superior margin.
 8. Middle and inferior conchae.
 9. Hard palate.



Postero-anterior radiograph of skull taken with head tilted backwards.

1. Frontal sinus.
2. Orbit.
3. Zygomaticofrontal suture.
4. Zygomatic bone.
5. Maxillary sinus.
6. Coronoid process of mandible.
7. Nasal cavity and sphenoidal sinus superimposed.

GUIDE FOR PRACTICAL CLASS # 5

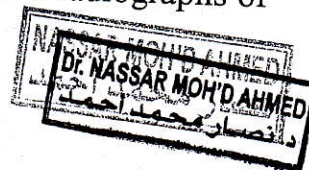
Theme: SKELETON OF THE HEAD (SKULL)

Summary: Skull as a whole. Radiological and surface anatomy.

Objectives:

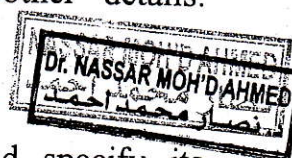
1. To describe the general aspect of the skull as a whole through the different views (normae), indicating them in the skull.
2. To identify in the surface of the head and in a radiographs of this region the prominent bony features.

Methodological orientations (TASKS)



1. In a superior (Norma Verticales) view of the skull, identify the bones, sutures and most important anatomical features. Utilize Atlas, figure 67.
2. In a posterior (Norma Occipitales) view of the skull, identify the bones and sutures and show the more important features. Utilize Atlas, figure 68.
3. In a lateral (Norma Laterales) view of the skull, identify the bones and sutures and show the more important features. Utilize Atlas, figure 56.
 - Indicate the temporal, infratemporal and pterigopalatine fossae and describe their particular characteristics. Utilize the Atlas, figures 56, 60, 117, 118 and 120.
 - Analyze how is formed the temporo-mandibular joint. Utilize Atlas, figures 208 and 209.
4. In an anterior (Norma Frontales) view of the skull, identify the bones, cavities and principal features. Utilize Atlas, figure 54.
 - Show the orbital cavities and describes their particular characteristics: situation, walls and their constitution, openings and communications. Utilize the Atlas, figures 114, 115 and 116.

- Show the piriform aperture and point out its boundaries. Utilize Atlas, figure 55.
5. In the inferior (Norma Basales) view of the skull, identify the parts (regions) and their limits, bones that form each part and the most important anatomical features. Utilize Atlas, figure 60.
6. In a horizontal section of the skull:
- Observe the internal (or superior) aspect of the base and identify the cranial fossae, their limits, bones that form each fossa and indicate the most important anatomical features. Utilize Atlas, figure 62.
 - Observe the internal surface of the calvaria and show the vascular sulci and other details. Utilize Atlas, figure 69.
7. In a sagittal section of the skull:
- Identify the paranasal sinus and specify its communications with the nasal cavity. Utilize Atlas, figures 119 and 120.
 - Show the nasal cavity and describe its particular characteristics. Point out the constituents bones of the different walls, openings and communications. Utilize the Atlas, figures 54, 97, 114, 119 and 120.
8. **Surface anatomy:** In the human body surface show the more prominent bony features in the head (landmarks).
- **In frontal view:**
 1. *Frontal eminence:* is the area of maximum convexity on either side of the forehead.
 2. *Superciliary arch:* forms a rounded elevation above the medial half of the eyebrow.
 3. *Glabella:* is a median elevation above the root of the nose and connects the two superciliary arches.
 4. *Nasion:* is the center of the depression at the root of the nose between the two supra-orbital margins.



5. *Supraorbital notch*: may be palpated two finger breadths from the two supraorbital margins.
6. *Zygomatic bone*: forms the bony prominence of the cheek.
7. *Infraorbital foramen*: is placed 1 cm below the infraorbital margin and a finger breadth from the side of the nose.
8. *Anterior nasal spine*: may be felt in the lower border of the free part of the nasal septum between the two nostrils.
9. *Body of mandible*: is felt below the lower lip and cheeks. Trace its lower border backwards to the angle of mandible.
10. *Mental foramen*: is placed two finger breadths from the median plane and a finger breadth above the lower border of the mandible. A vertical line joins supraorbital notch, infraorbital foramen and mental foramen.



In side view:

1. *Condylar process*: includes neck and head of the mandible. The neck is felt in front of the lobule of the auricle. The head lies in front of the tragus. Place your finger tip in front of your own tragus and open your mouth, the head of mandible is felt gliding downwards and forwards.
2. *Zygomatic arch*: is the the bony ridge that spans the interval between the tragus and the bony prominence of the cheek.
3. *Parietal eminence*: is the most convex part of parietal bone in the region where the back, the top and the side of the head meet.
4. *Mastoid process*: is the smooth rounded bone behind the lower part of the auricle.
5. *Inion*: is the apex (top) of *external occipital protuberance*.
6. *Suprameatal triangle*: is a small depression above and behind the *external acoustic meatus*.

The triangle is surgically important because it overlies the **mastoid antrum**.

➤ **Fontanelles and sutures:**

1. In a newborn or small infant it is very easy to palpate the fontanelle:
 - *Anterior*, between the frontal and parietal bones.
 - *Posterior*, between the occipital and parietal bones.
2. If you are able to localize the following points:
 - *Bregma*: 2.5 cm anterior to the mid-point of a curved line joining both external acoustic meatus.
 - *Lambda*: 6 cm above the inion.
 - *Pterion*: 3.5 cm behind the fronto-zygomatic suture and 4 cm above the mid point of the zygomatic arch.
 - *Asterion*: 1 cm above the midpoint of a line between the tragus and inion.



Now you can palpate the sutures of the cranial vault:

- *Coronal*: runs between the bregma and the pterion of each side.
- *Sagittal*: runs in the midline between the bregma and the lambda.
- *Lambdoid*: runs from the lambda to the asterion of each side.

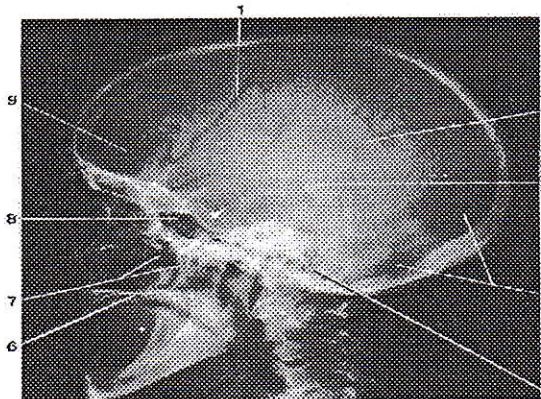
9. **Radiological anatomy:** Interpret the main bony features seen in the radiographs of the skull. (see pictures in following page)

- **In frontal view** you can indicate the mandible, teeth, nasal cavity, paranasal sinuses (maxillary and frontal), the petrous part of temporal bone, the orbit and some sutures.
- **In a lateral view**, observe the sutures, all paranasal sinuses, the roof of the orbit, the hypophyseal fossa and the radiograph of the petrous part of the temporal bone.

10. Explain the more important variation of the cranium in relation with sex and age. Use a skull to show them.

Bibliography

- Cunningham's textbook of Anatomy. 12th edition. Pages 108 to 136 and 225 to 226.
- Sobotta/Figge. Atlas of Human Anatomy. Vol 1. Pages 30 to 43 and 58 to 63.
- Learning guide to Practical Anatomy I. Pages 13 to 22 may auxiliary you in the study of surface and radiological anatomy.

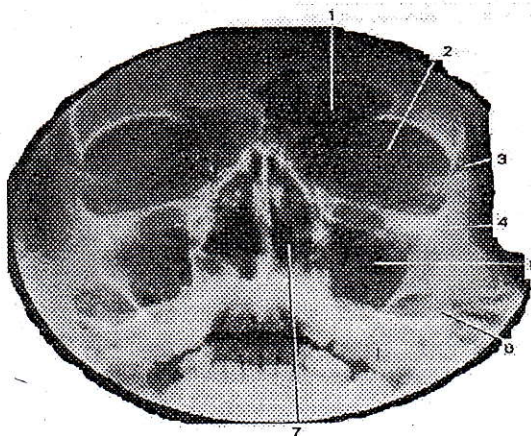
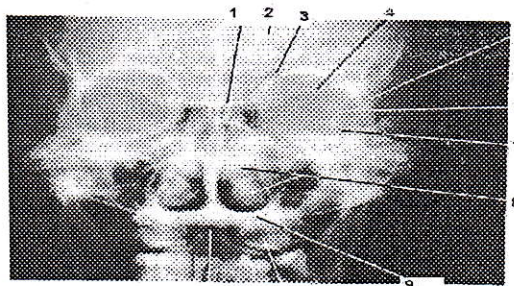


Lateral radiograph (slightly oblique) of adult, edentulous head.

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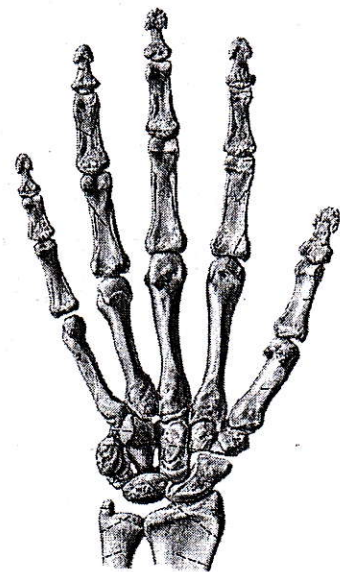
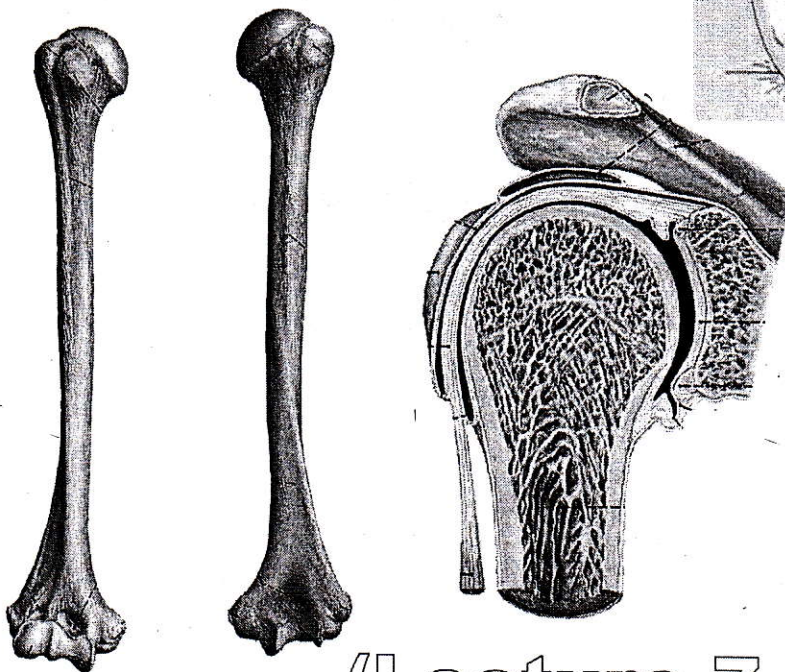
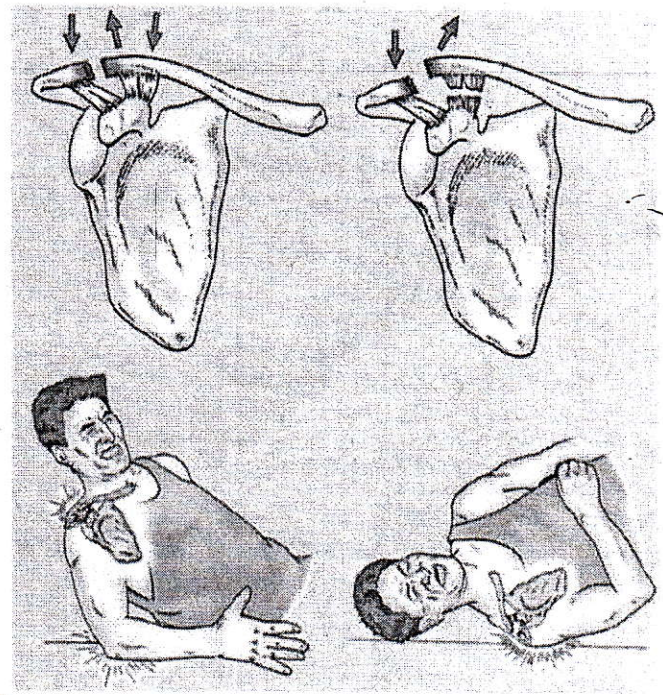
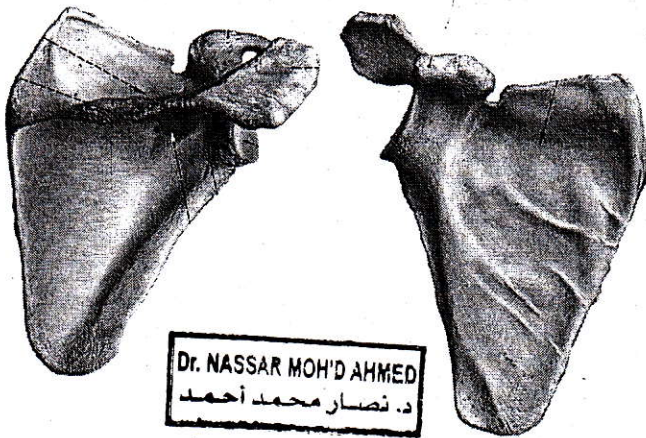
- Postero-anterior radiograph of skull with hard palate horizontal.
1. Central part of floor of anterior cranial fossa.
 2. Margin of frontal sinus.
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Postero-anterior radiograph of skull taken with head tilted backwards.

1. Frontal sinus.
2. Orbit.
3. Zygomaticofrontal suture.
4. Zygomatic bone.
5. Maxillary sinus.
6. Coronoid process of mandible.
7. Nasal cavity and sphenoidal sinus superimposed.

APPENDICULAR SKELETON: UPPER LIMB



(Lecture 7)

acromial end is flat - concave -
sternal is round - convex

2

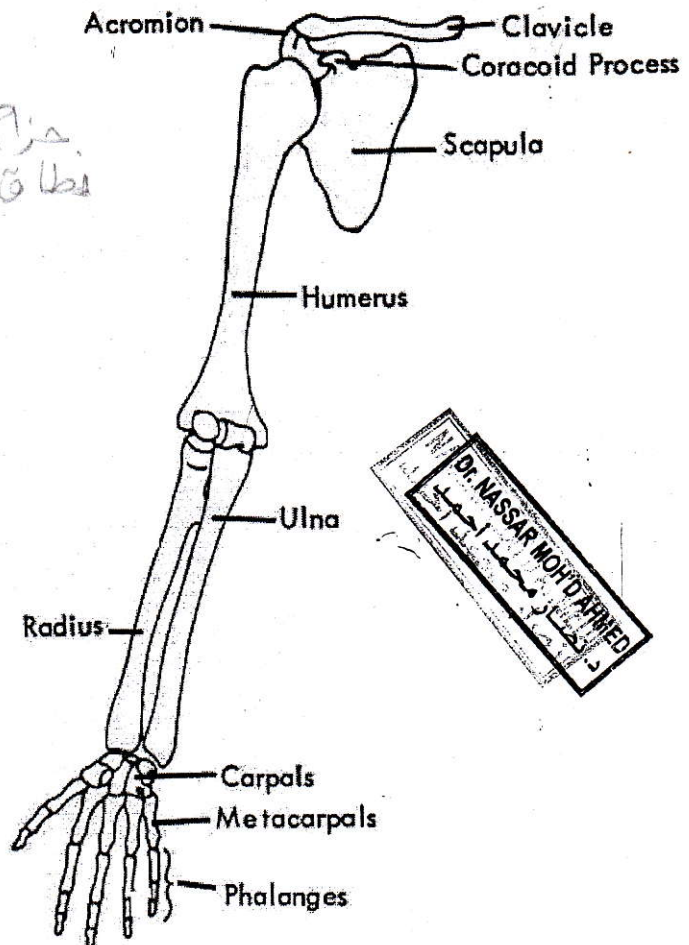
Generalities

For descriptive purposes, the upper limb is divided into four regions:

- Shoulder region (shoulder girdle or pectoral girdle)
- Arm (brachium)
- Forearm (ante brachium)
- Hand (manus), which is subdivided itself into three regions; wrist (carpus), hand proper (metacarpus) and finger (digit).

Bones of each region:

- Shoulder girdle: clavicle and scapula
- Arm: humerus
- Forearm: ulna and radius
- Hand: carpal bones (8), metacarpal bones (I to V), phalanges of the fingers (proximal, middle and distal except in the thumb which have only proximal and distal)



The upper limb is articulated to the axial skeleton only by the sternoclavicular joint. The rest of the attachments are muscular.

The shoulder region is supported by the two bones of the shoulder girdle: the **clavicle** (collar bone), and the **scapula** (shoulder blade).

THE CLAVICLE

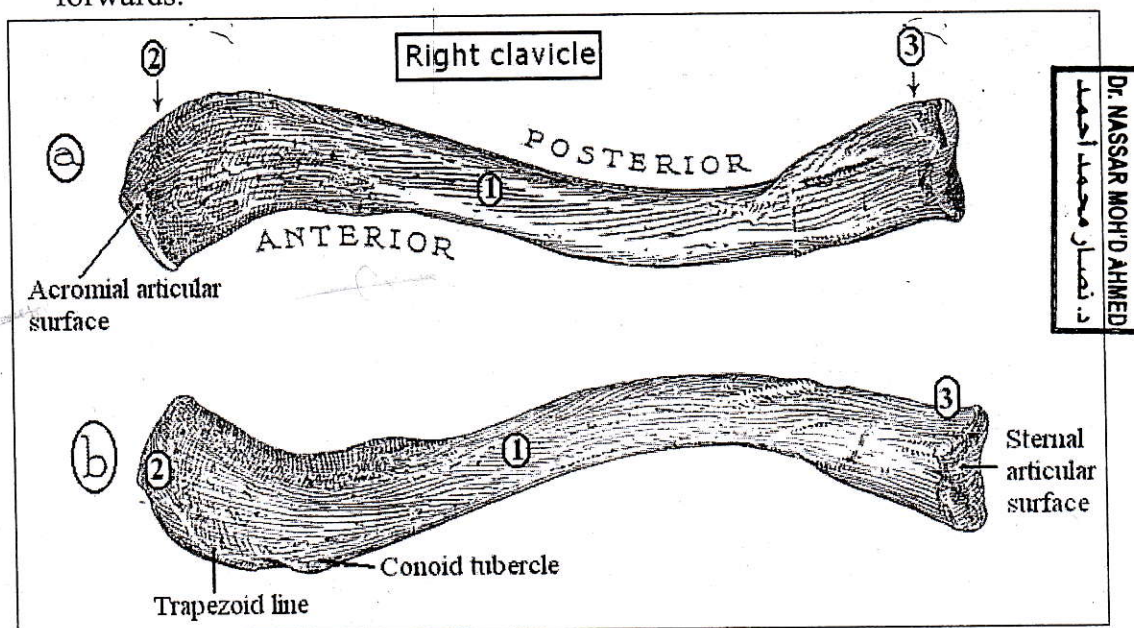
It is a long bone placed horizontally between the manubrium of the sternum to the acromion of the scapula, over the first rib.

Portions: **body** or central part (1), lateral or **acromial end** (2) and medial or **sternal end** (3).

Surfaces: upper or superior (a) and lower or inferior (b).

Anatomical position: to place this bone in the correct position you should take into account that:

- The upper surface is smooth while the lower surface irregular with conoid tubercle and trapezoid line.
- The lateral (acromial) extremity is flat.
- The medial third is convex forwards while the lateral third is concave forwards.



The clavicle is the first bone to begin ossification. Primary ossification centers appear during the 5th week intrauterus. It may be a useful radiological sign to evaluate the course of the pregnancy and the fetal development.

THE SCAPULA

It is a flat bone with a **triangular-shaped**, applied to the back of the second to the seventh ribs. According the shape we can distinguish two surfaces, three borders and three angles.

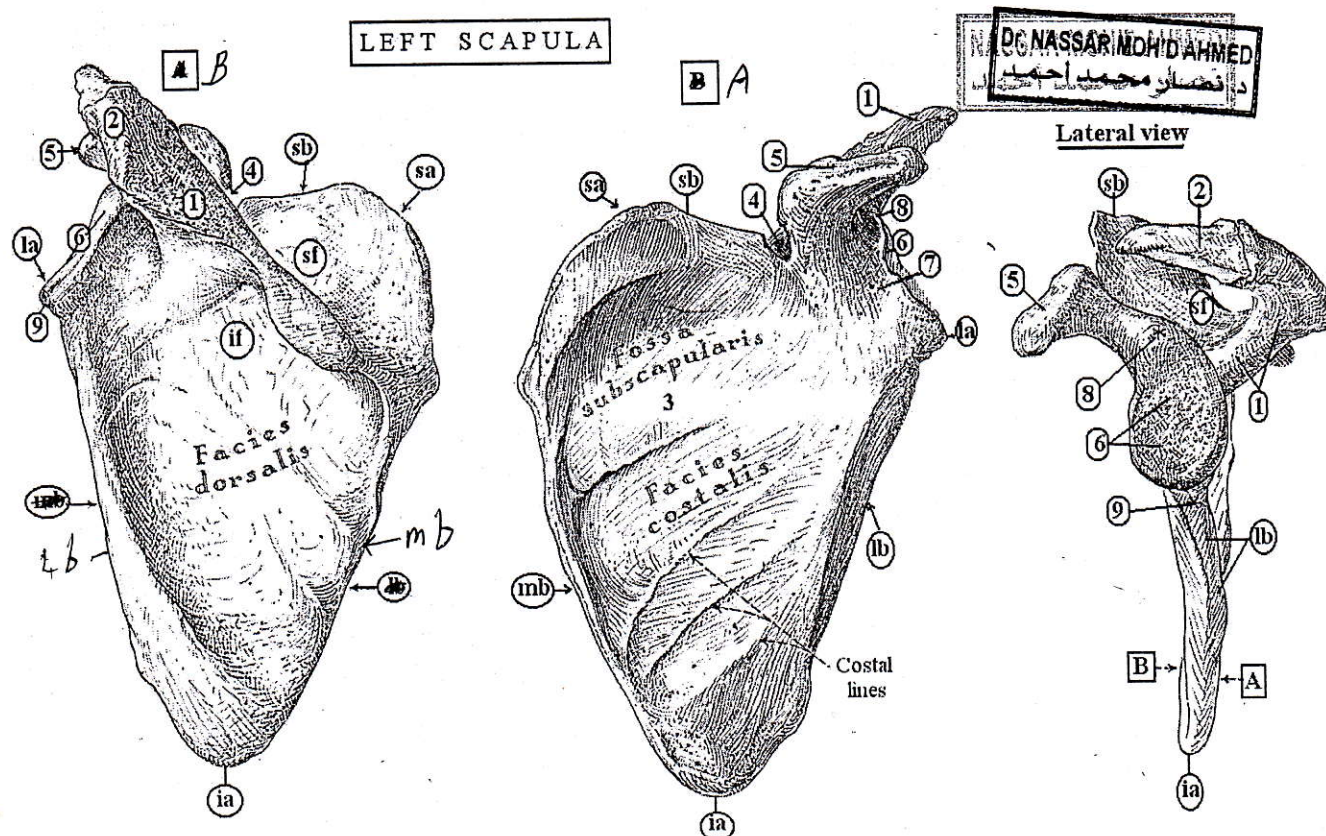
Surfaces: **anterior** or costal (A) and **dorsal** or posterior (B). The posterior surface is divided into **supra-spinous (sf)** and **infra-spinous (if)** fossa by the **spine (1)** of the scapula which ends lateral wards in the **acromion (2)**. The anterior surface shows the **sub-escapular fossa (3)**.

Borders: **superior (sb)**, where we can identify the **scapular notch (4)** and the **coracoid process (5)**, **medial (mb)**, which is vertical and parallel to the vertebral column and **lateral (lb)**, obliquely placed.

Angles: the superior angle (**sa**) is rounded, the inferior or lower (**ia**) is acute and prominent, and the lateral (**la**) contains the **glenoid cavity (6)** to join with the head of the humerus. This important articular surface is bounded by the **neck (7)** of the scapula and two tubercles: above the **supraglenoid tubercle (8)** and below the **infraglenoid tubercle (9)**.

Now is very easy to place the bone in anatomical position: the long, oblique process (**spine**) is posterior, and its enlarged end (**acromion**) is directed laterally (outwards), the concave surface (**costal surface**) is anterior, the prominent (lower) angle is directed downwards, and the articular (**glenoid**) cavity is placed laterally.

And also you should identify the most important anatomical details.



THE HUMERUS

It is the bone of the arm and it is a typical long bone.

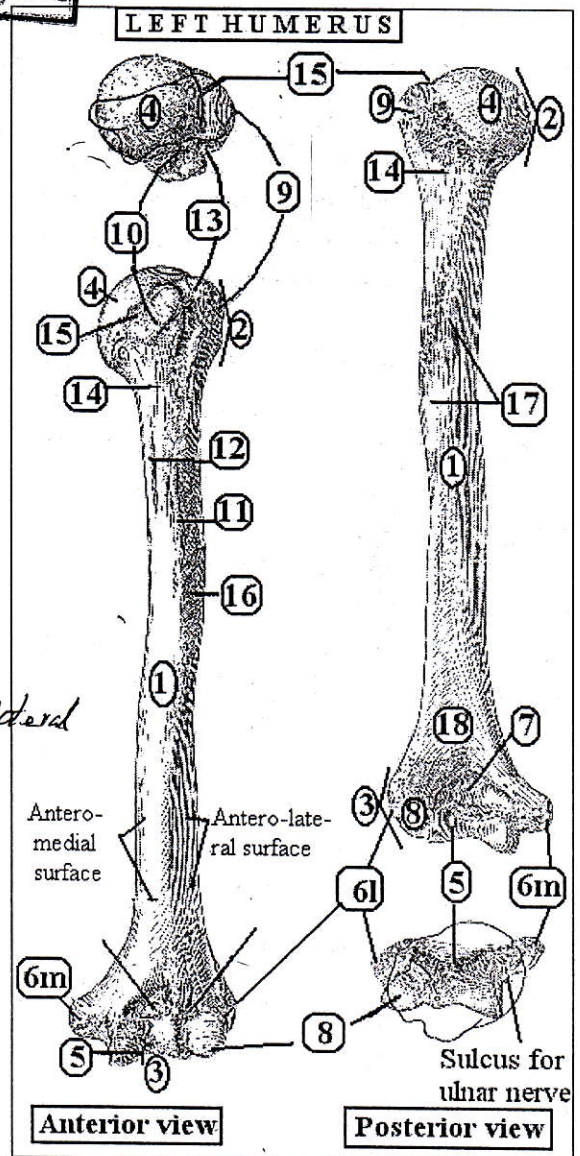
Portions and anatomical position:

1. Diaphysis, body or shaft: central part.
2. Proximal end or epiphysis: characterized by a spherical **head** (4) directed medially.
3. Distal end or epiphysis: characterized by the **trochlea** (5), lateral and medial **epicondyles** (6) and a large **olecranon fossa** (7) backwards.

Important anatomical details:

- Articular details:
 - a. Proximally: **head** of humerus (4), to join with the glenoid fossa of scapula.
 - b. Distally: **trochlea** (5) and **capitulum** (8), to join with the ulna and radius respectively.
- Non-articular details:
 - a. In the proximal end we find: the **greater** (9) and **lesser** (10) tubercles with the corresponding **crests** (11 & 12) towards the diaphysis, and the **inter-tubercular sulcus** (13). Also it is necessary to distinguish the **surgical neck** (14) from the **anatomical neck** (15).
 - b. In the diaphysis we can see: the **deltoid tuberosity** (16) in the ~~anterior~~ *lateral* aspect and the **radial (spiral) groove** (17) in the posterior aspect. The lower part is prismatic-shaped so that we can distinguish three surfaces and three borders. The **posterior surface** (18) is flat and like a triangle.
 - c. In the distal end we find: the **medial** (6m) and **lateral** (6l) epicondyles, the **olecranon fossa** (7) and the **radial** (19) and **coronoid** (20) fossae.

DR. NASSAR MOH. DAHMED
د. ناصر محمد الدحميد



spiral = radial

BONES OF THE FOREARM

The skeleton of the forearm comprises two bones; the **ulna** and the **radius** which are articulated parallel one another. The ulna is placed at the medial side and the radius is at the lateral side (thumb-side). As typical long bones, they show three portions: a central diaphysis or body and two epiphysis or ends (proximal and distal). To differ one from the other –when they are isolated- is important to compare the size and shape of the epiphysis: **the proximal end of radius is smaller than the distal end** and in the ulna is conversely.

THE ULNA

Main details in each portion and how to place it in anatomical position:

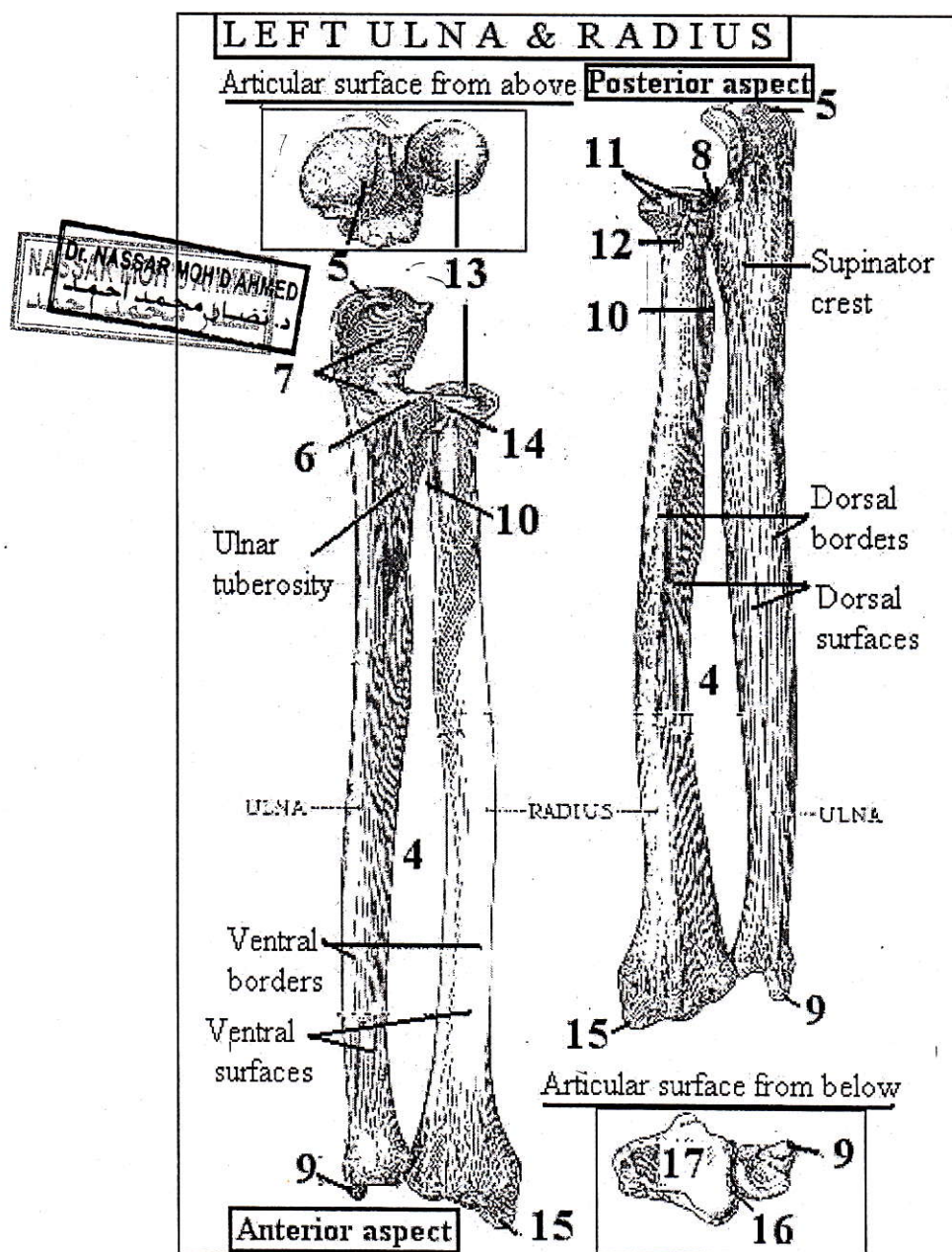
1. Diaphysis, body or shaft: central portion characterized by a sharp **lateral interosseous border (4)** directed laterally, towards the homonymous border of the radius. Since the body is prismatic in shape, we can also distinguish anterior and posterior **borders** and ~~lateral interosseous border~~, and **three surfaces**: anterior, posterior and medial.
2. Proximal end: characterized by its larger size, a prominent **olecranon (5)**, the **coronoid process (6)**, and **the trochlear notch (7)** between them. The olecranon is directed backwards while the coronoid process and the trochlear notch are directed forwards (anterior). Also we can see the **radial notch (8)** directed laterally (towards the radius).
3. Distal end: smaller, characterized by a round head and the **styloid process (9)**, which is orientated backwards

THE RADIUS

Main details in each portion and how to place it in anatomical position:

1. Diaphysis, body or shaft: central portion characterized by a sharp, medial **interosseous border (4)** directed medially towards the homonymous border of the ulna. Also we can distinguish anterior and posterior **borders** and **three surfaces**: anterior, posterior and lateral. The **radial tuberosity (10)** lies medially in the uppermost part of the body.

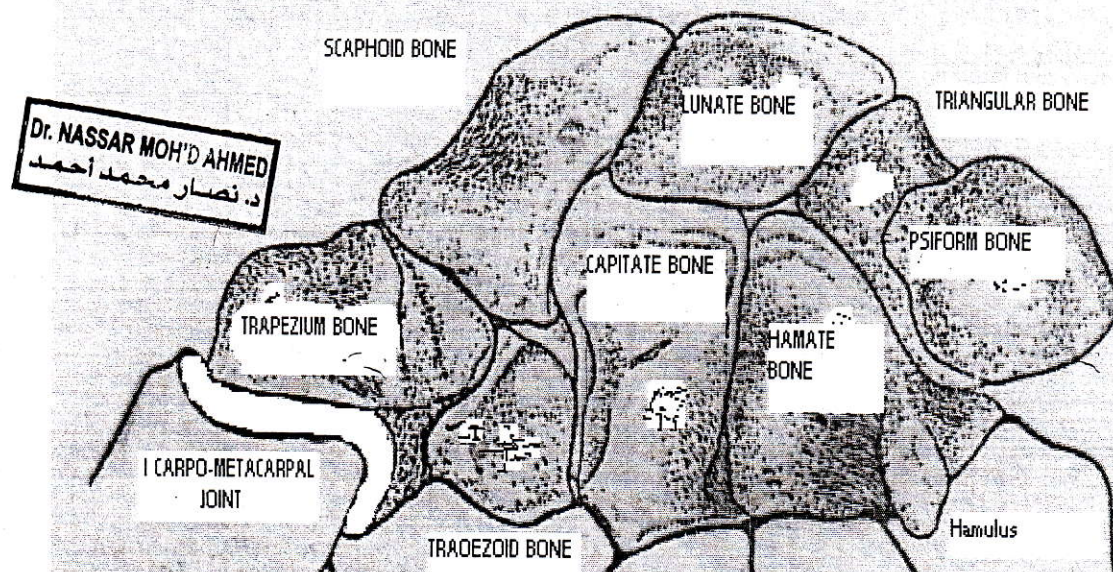
2. Proximal end: it is smaller and comprises the **head** (11) and the **neck** (12). In the head there are two articular surfaces: the **articular fossa** (13), to join with the capitulum of the humerus and the **articular circumference** (14), to join with the radial notch of the ulna.
3. Distal end: it is larger. The ventral surface is smooth and concave while the dorsal surface is irregular. The **styloid process** (15) is directed downwards and backwards at the lateral side. Also we can see the **ulnar notch** (16) and the carpal articular surface (17).



Proximal: scaphoid - lunate - triquetral - pisiform
 Distal: trapezium - trapezoid - capitate - hamate⁸

CARPAL BONES: CARPUS

They are eight short bones which are arranged around the largest one, the **capitate** but they are commonly described as forming two rows, the proximal and the distal rows: proximal and distal.



Ossification: All carpal bones are cartilaginous at birth. Each carpal bone ossifies from one center. These ossification centers appear after birth. These characteristics, also with the fact that the hand is a region easy to study radiologically, make useful the knowledge of the ossification times and order of the carpal bones.

The carpal bones articulate with each other and are bound together by ligaments so as to form a compact mass which is curved with a posterior convexity and a pronounced anterior concavity, the **carpal sulcus**. This is converted into a **carpal canal or tunnel** by the flexor retinaculum.

The carpal sulcus or grove is formed by:

Crest of Trapezium-----distal-----Hook of hamate

Laterally Medially

Tubercle of Scaphoid -----proximal-----Pisiform

The proximal row from lateral are (Scaphoid, lunate, triquetral, pisiform)

The distal row from lateral are (Trapezium, trapezoid, capitate, hamate)

The carpal tunnel is completely filled during life by tendons of the flexor muscles and the median nerve.

medial 31 lateral 22

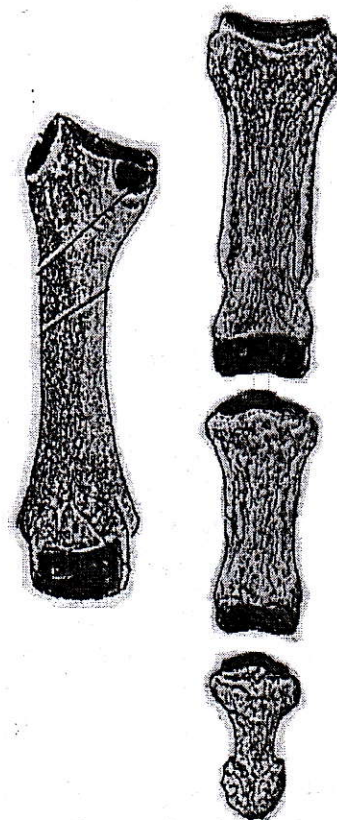
METACARPAL BONES

The skeleton of the hand proper or **metacarpus** consists of five miniature long bones, the **metacarpal bones**; they are numbered in order from the lateral side to the medial side:

First metacarpal -----→ of the -----→ thumb
 Second metacarpal ----→ of the -----→ index finger
 Third metacarpal -----→ of the -----→ middle finger
 Fourth metacarpal ----→ of the -----→ ring finger
 Fifth metacarpal -----→ of the -----→ little finger

Each one consists of three portions:

- Shaft or body.
- Base (proximal end) to join with carpal bones (distal row).
- Head (distal end) to join with the base of the proximal phalanx of the corresponding finger.



PHALANGES OF THE FINGER

Each phalanx is a miniature long bone with three portions:

- Shaft or body.
- Base or proximal end.
- Head or distal end.

Each finger (except for the thumb) has a skeleton of three phalanges: **proximal, middle and distal**.

SESAMOID BONES

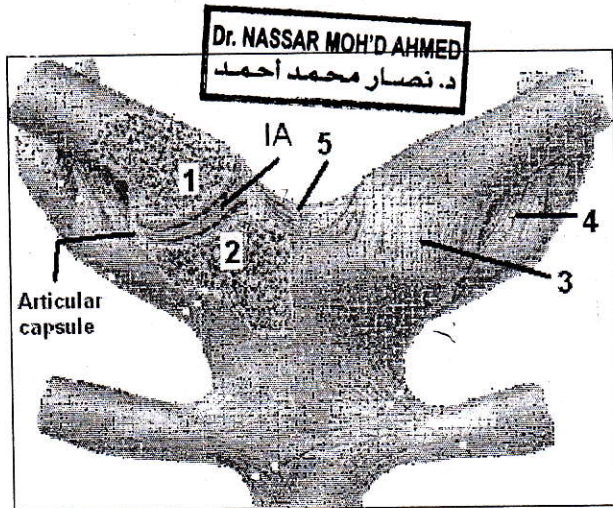
As a rule, only two sesamoid bones are found in the hand at the palmar side of the metacarpophalangeal joint of the thumb.

JOINTS OF THE UPPER LIMB

JOINTS OF THE SHOULDER GIRDLE

1. Sternoclavicular joint

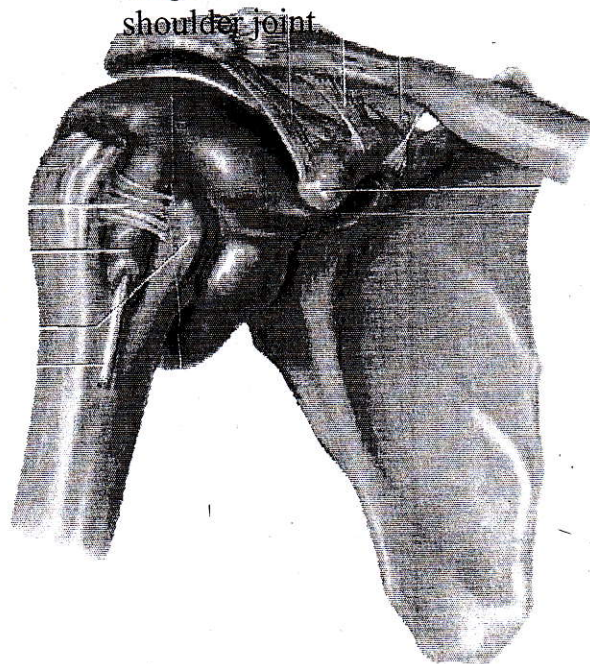
- Classification: it is synovial, simple, complex, (because of the intra-articular disc) biaxial and saddle according the shape of the articular surfaces.
- Articular surfaces: sternal end of the clavicle (1) and clavicular notch (2) of the manubrium of the sternum.
- Articular cavity: is completely divided into two compartments by the intra-articular disc (IA).
- Ligaments: anterior and posterior sternoclavicular (3), costoclavicular (4) and interclavicular (5).



2. Acromioclavicular joint

- Classification: it is synovial, plane non-axial.
- Articular surfaces: lateral (acromial) end of the clavicle and acromion of the scapula.
- Ligaments: acromioclavicular and coracoclavicular (conoid + trapezoid).
- Movements of the clavicle: the clavicle can perform small movements at both ends; but in all directions. Movements of the shoulder girdle serve to increase the

range of movement at the shoulder joint



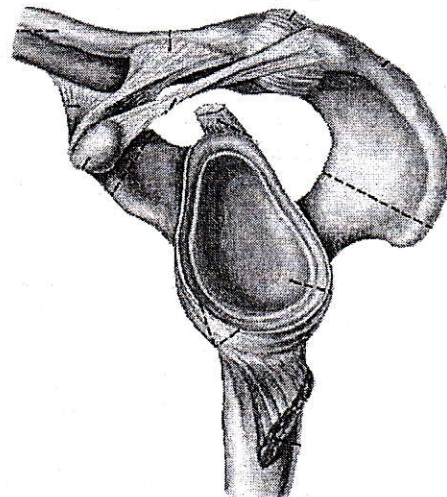
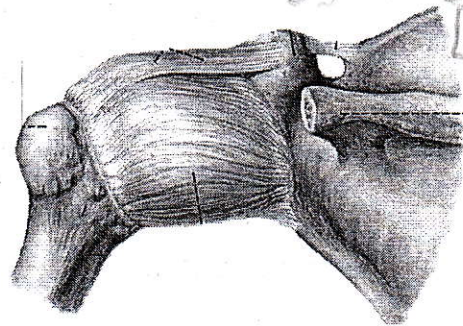
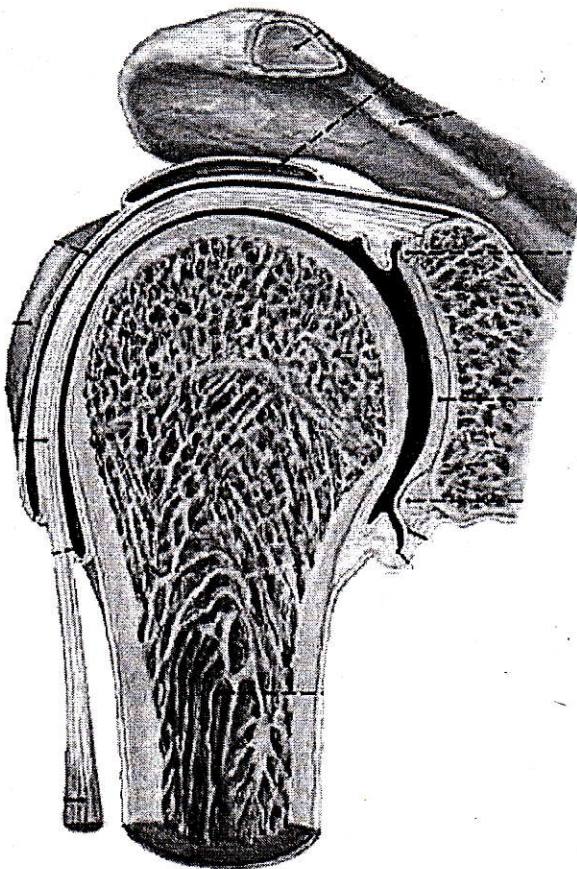
نقطة
الموقع
فقط

3. Shoulder joint

simple,

- Classification: it is synovial, [↑] multi-axial spheroidal (ball-and-socket), complex (labrum present).
- Articular surfaces: head of the humerus (**H**) and glenoid cavity of the scapula (**S**). A fibro-cartilaginous rim, **the labrum glenoidal** (**L**) attaches to the margin of the glenoid cavity and deepens it.
- Ligaments:
 1. Glenohumeral ligaments (superior, middle and inferior). At the internal surface of the anterior part of the capsule (**C**). Not visible on the outside of the joint.
 2. Coracohumeral ligament (accessory ligament).
 3. Coracoacromial ligament (accessory ligament).
- Movements:
 - ✓ Flexion-extension
 - ✓ Adduction-abduction.
 - ✓ Rotation (lateral and medial).
 - ✓ Circumduction.

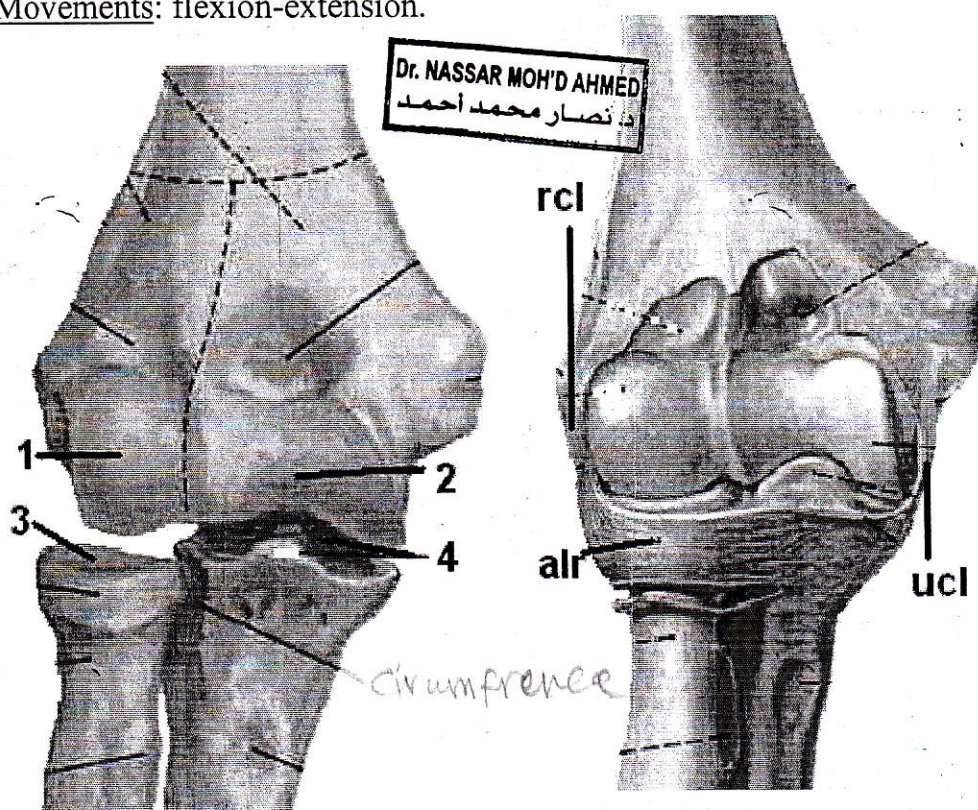
*acromioclavicular
capsul is below
deltoid muscle*



JOINTS OF THE FOREARM

1. Elbow joint

- Classification: it is synovial, compound, of hinge or ginglymus type.
- Articular Surfaces: capitulum (1) and trochlea (2) of humerus, articular fossa (3) of head of radius and trochlear notch (4) of ulna, and circumference articular surface (5) and radial notch of ulna.
- Ligaments: radial collateral ligament (**rcl**) and ulnar collateral ligament (**ucl**), and annular ligament (**alr**).
- Movements: flexion-extension.



2. Radio-ulnar joints (PRUJ):

a) **Proximal radio-ulnar joint**: as you can see above, it is included in the articular capsule of the elbow joint.

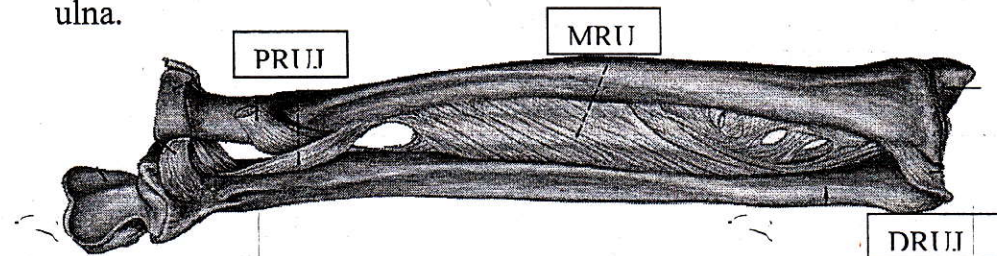
- Classification: it is synovial, simple, pivot or trochoid type and combined with the distal one.
- Articular surfaces: radial notch of the ulna and articular circumference of the head of radius.
- Ligaments: annular ligaments of the radius (**alr**)

b) Distal radio-ulnar joint (DRUJ)

- Classification: it is synovial, simple, pivot or trochoid type and combined with the proximal one.
- Articular surfaces: head of the ulna and ulnar notch of the radius. The triangular disc (D) provides an additional articular surface.

c) Middle radio-ulnar joint (MRUJ)

- Classification: it is fibrous syndesmosis, represented by an interosseous membrane joining the shafts of both radius and ulna.



Movements at the radio-ulnar joints: rotatory movements around vertical axis: pronation and supination.

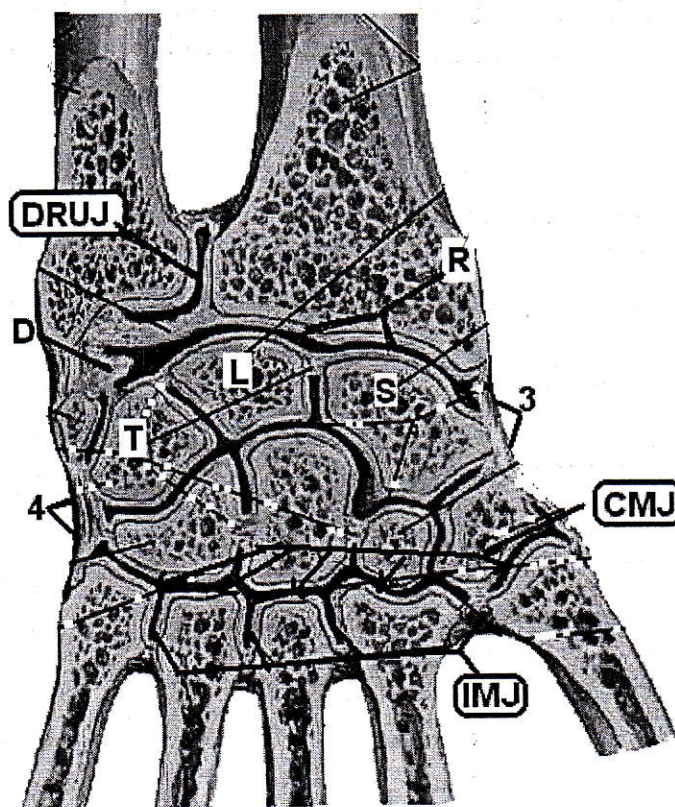


RADIOCARPAL or WRIST JOINT

- Classification: it is synovial, compound, complex (articular disc present) and ellipsoid type.
- Articular surfaces:
 - ✓ Proximal → distal end of radius (R) and the articular disc (D).
 - ✓ Distal → proximal articular area of scaphoid (S), lunate (L) and triquetrum (T) bones of the proximal row of carpus.
- Ligaments:
 1. Palmar radiocarpal lig.
 2. Palmar ulnocarpal lig.
 3. Radial collateral carpal lig.
 4. Ulnar collateral carpal lig.
 5. Dorsal radiocarpal lig.
- Movements:
 - ✓ Flexion-extension.
 - ✓ Adduction-abduction.
 - ✓ Oblique movements and circumduction are also possible.

INTERCARPAL JOINTS

The joints between the individual bones of the carpus are mostly of the plane variety, but the capitate rotates considerably during movements of the hand. Between the bones of the first row and those of the distal row, the **midcarpal joint** is formed. The principal movements of the carpal bones occur at the midcarpal, usually associated with movements at the radiocarpal joint.



CARPOMETACARPAL JOINTS (CMJ)

They are established between the bases of the metacarpal bones and the distal row of carpus. **The carpometacarpal joint of the thumb** (between trapezium and the base of the first metacarpal bone) is of the saddle type allowing considerable movement for the thumb; flexion-extension, abduction-adduction, opposition and also circumduction. **The carpometacarpal joint of the little finger** (between hamate and the base of the fifth metacarpal bone) is of a flattened saddle type allowing opposition of the little finger. The rest of the carpometacarpal joints named **common carpometacarpal joints**.

*simple
sellar
simple,
biaxial*

INTER-METACARPAL JOINTS (IMJ):

They are formed between contiguous sides of medial four metacarpal bones, are classified as plane type, allowing very little movement.

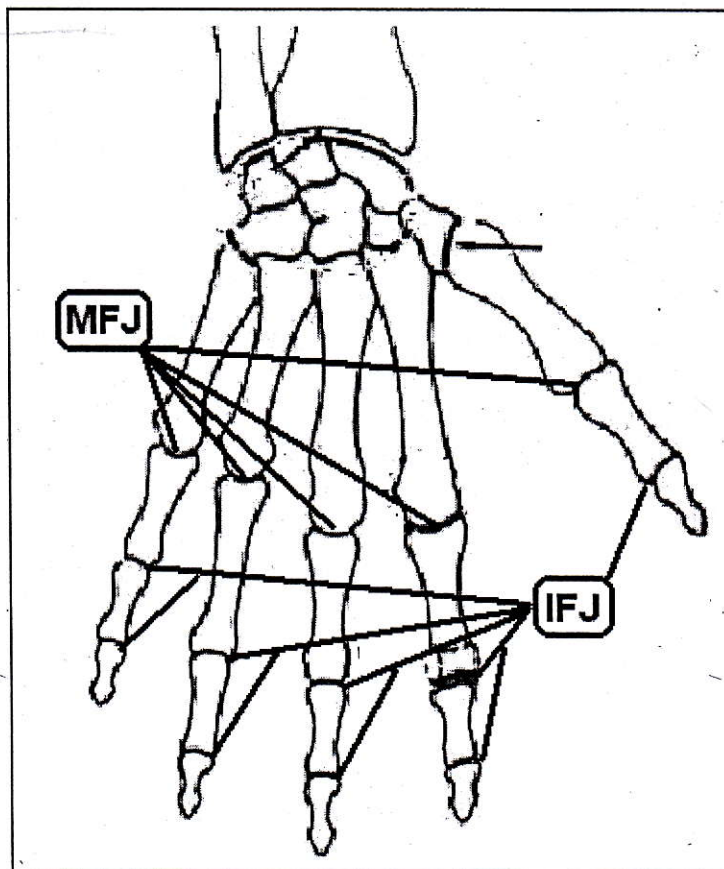
METACARPOPHALANGEAL JOINTS (MFJ)

- Classification: it is synovial, *saddle* *braxial* condyloid and simple.
- Articular surfaces: head of the metacarpal bone and base of the proximal phalanx.
- Ligaments:
 - ✓ Palmar ligament
 - ✓ Collateral ligament
 - ✓ Deep transverse metacarpal lig. (for the medial four metacarpal).
- Movements: flexion-extension and abduction-adduction. The metacarpophalangeal joint of the thumb has much less extensive movements than the others.



INTERPHALANGEAL JOINTS (IFJ)

- Classification: it is synovial, simple, hinge *saddle* *and* *trochlear*.
- Articular surfaces: the head and base of the corresponding phalanges.
- Movements: only flexion-extension.

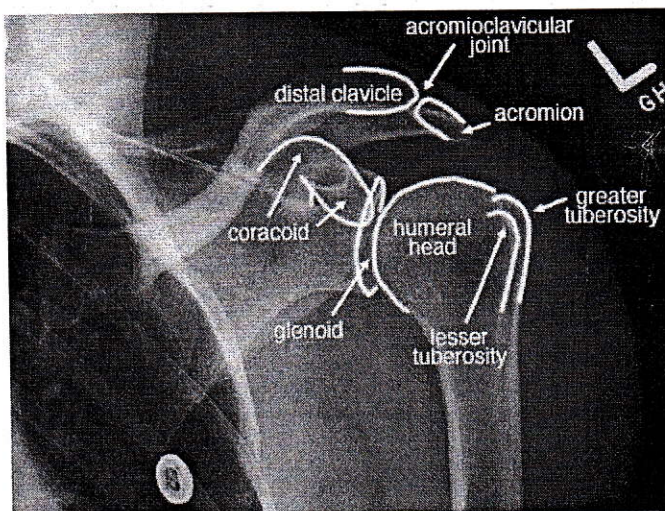


MOVEMENTS OF THE HAND AS A WHOLE

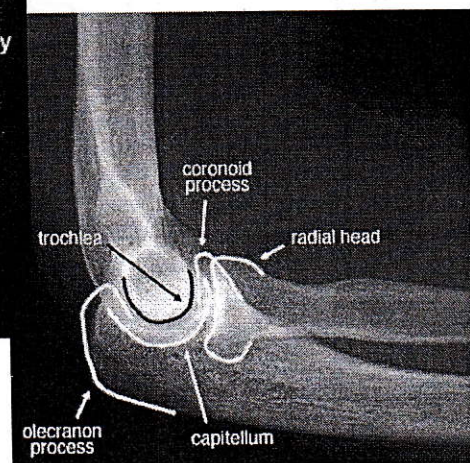
All the hand's movements may be divided into two main groups:

1. **Non-prehensile movements:** the objects are manipulating by pushing or lifting.
2. **Prehensile movements:** an object is seized and held wholly or partly within the grasp of the hand. This group of movements may be further subdivided into:
 - **Power grip:** the object is clamped by the partly flexed finger and palm, with counter pressure applied by thumb. It is used for carrying heavy objects and for controlling tools and machinery.
 - **Precision grip:** the object is pinched between the fingers and the opposing thumb. It is used for all fine works with small object, such as sewing and writing.

Something about **RADIOLOGICAL ANATOMY**



Two important joints and
Some details belonging
to 5 bones of upper limb.



GUIDE FOR PRACTICE CLASS # 5

Theme: SKELETON OF THE UPPER LIMB

Summary:

- ☐ Bones of the upper limb.
- ☐ Joints of the upper limb.
- ☐ Surface and radiological anatomy.

Objectives:

1. To identify in the human skeleton the bones and joints of the upper limb.
2. To describe the particular characteristics of the bones and main joints of this skeleton region, identifying them in the already prepared anatomical pieces.
3. To identify the most relevant bony features in the body surface and by radiographs.

Methodological orientations (TASKS)



Follow the general orientations about osteology and arthrology in order to point out the general characteristics of the required bones and joints.

1. Identify the bones of the upper limb in an articulated skeleton. Use Atlas.
2. In a group of bones, identify the clavicle, scapula, humerus, radius and ulna and describe their particular characteristics.
 - Use Atlas: figures 122 to 138.
 - Some considerations should be taken into account in order to put each bone in the anatomical position. For example:

1st.Clavicle: must be putted in the frontal plane. The lateral half is flattened and concave forward and the medial half is rounded and convex forward. The superior surface is smooth.

2nd.Humerus: the longitudinal axis is vertical, rounded above and flattened below. The hemispherical head faces superiorly, medially and slightly posterior.

3. Identify in the skeleton of the hand, the division into regions and the bones from each region. Utilize Atlas: figures 142, 143.

4. Indicate in the skeleton and / or in the Atlas' figures the joints of the upper limb: sternoclavicular, acromioclavicular, glenoclavicular, elbow, radioulnar (proximal, middle and distal), wrist, intercarpal (midcarpal), carpometacarpal, metacarpophalangeal and interphalangeal.

- Classify them.
- Do the movements that take place at these joints, mentioning the axis of these movements.
- Describe the particular characteristics of the greater joints (the underlined).
- Utilize Atlas: figures 216 to 223.



5. **Surface anatomy:** identify the more distinct bony features on the skin surface of the upper limb like : clavicle, infraclavicular fossa, acromion, the spine of the scapula, the greater tuberosity of humerus, the head of the humerus in the axilla when the shoulder is abducted, medial and lateral epicondyles of humerus, head of radius (in the depression on posterolateral aspect of the extend elbow...), olecranon process, styloid processes and some carpal bones. You may support on the 'Practical Anatomy I' booklet. Pages 25-26.

6. **Radiological anatomy:** identify the possible visible bony features in x-rays planes. We suggest you to recognize:

- In the shoulder region: a portion of clavicle, the proximal end of humerus and some details of the scapula.
- In the elbow region: all the anatomical details corresponding to the lower end of humerus, upper end of radius and upper end of ulna.
- In the wrist and hand region: the lower ends of radius and ulna and carpal, metacarpal and phalanges bones.

You may support on the 'Practical Anatomy I' booklet. Pages 30-32.

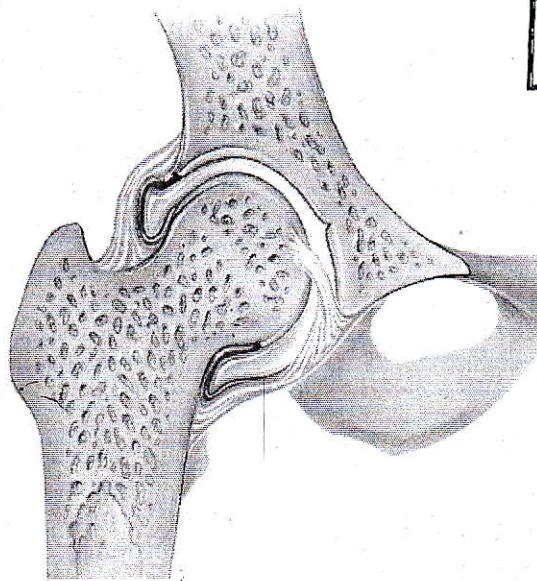
→ Use Atlas: figures 139 to 141 and 144 to 146.

Bibliography:

- Cunningham's textbook of Anatomy. Pages 150 to 174 and 228 to 242.
- Sobotta/Figge Atlas of Human Anatomy. Pages 66 to 76 and 108 to 115.

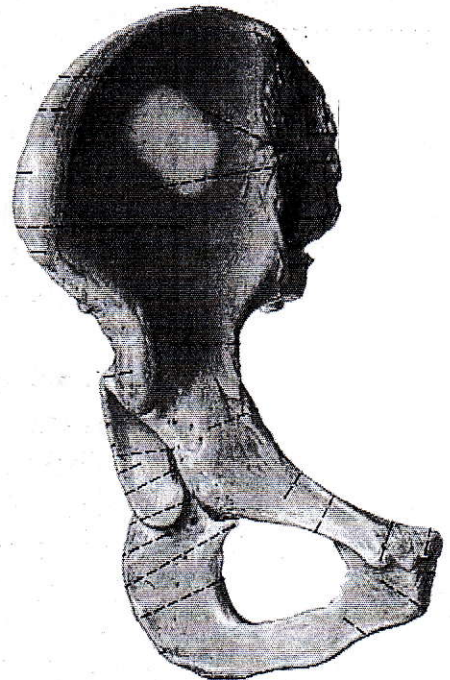
APPENDICULAR SKELETON

LOWER LIMB

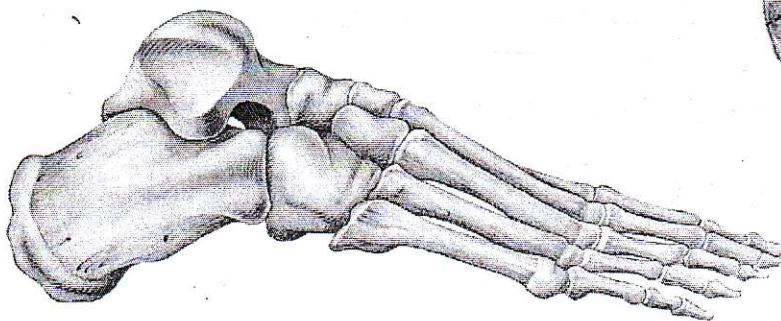


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(c) Lateral view

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{LECTURE 8}

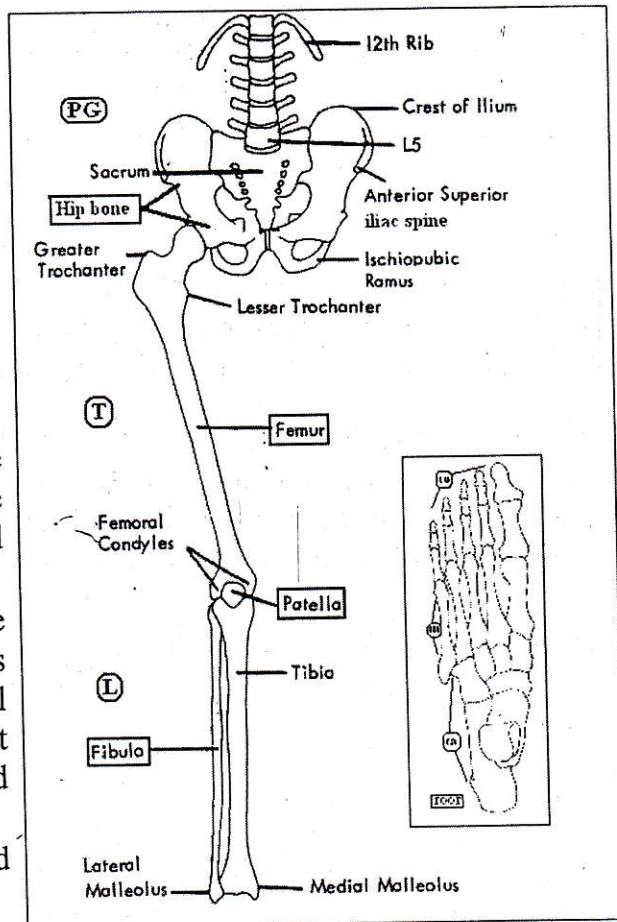
Generalities

For descriptive purposes, the lower limb is divided into four regions:

- Hip or pelvic girdle (PG)
- Thigh (T)
- Leg (L)
- Foot, which is subdivided itself into three regions: tarsus (ta), metatarsus (m) and toes (to).

Bones of each region:

- Pelvic girdle: it is formed by the **hipbones** of both sides, which join one another at the anterior midline by the **symphysis pubis**, and posteriorly with the sacrum.
- Thigh: **femur** bone and the **patella** bone. The last one is an important functional component of the knee joint which is customary described in the thigh.
- Leg: formed by the **tibia** and the **fibula**.
- Foot: **tarsal** bones (7), **metatarsal** bones (I to V) and **phalanges** of the toes (proximal, middle and distal except in the big toe which have only proximal and distal).



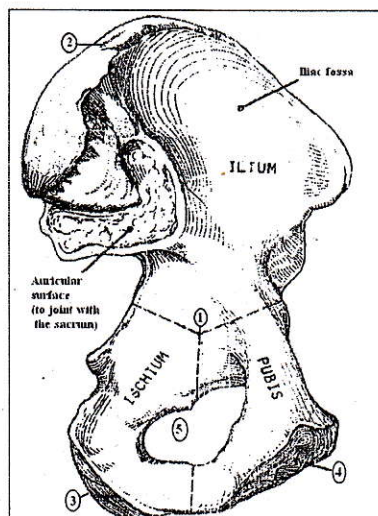
HIP BONE

The hipbone is a large, irregular bone, which form the pelvic girdle of the lower limb. It consists of three portions:

1. **Ilium** (superior)
2. **Ischium** (postero-inferior)
3. **Pubis** (antero-inferior)



These three portions remain independent, only joined by cartilage plates until puberty, when they ossify to form a single bone in the adult. They ossify at different stages of the puberty, starting from the intrauterine life. The plates of cartilage converge and meet at the **acetabulum** (1), the articular cavity for the head of femur.



Anatomical position: the **acetabulum** directed outwards, the wide **iliac crest** (2) directed upwards, the **ischial tuberosity** (3) down and backwards and the **symphysis pubis** (4) down and forward.

Note that, below the **acetabulum**, the **ischium** and the **pubis** limit a large orifice called **obturator foramen** (5). In the living subject, it is almost closed by the **obturator membrane** that leaves only on small, anterior aperture, the **obturator canal** for the obturator vessels and nerve.

In the **acetabulum**, we find the upper **lunate** (articular) **surface** for the head of femur, surrounding the **acetabular fossa** and, below them, the **acetabular notch**.

I. Ilium: it is divided into two portions:

1. **Body**: the narrow, lower portion, close to the **acetabulum**.
2. **Ala**: the wide, curved plate above the body.

The limits between them are the **arcuate line** (6) internally and the **inferior gluteal line** (7) externally.

The inner (pelvic) surface of the ala is depressed, forming the **iliac fossa**. The outer (external) surface is the **gluteal surface**, showing the insertions of the gluteal muscles: **anterior** (8), **posterior** (9) and **inferior** (7) **gluteal lines**. The superior border of the ala is the **iliac crest**, which splits into outer and inner **lips**.

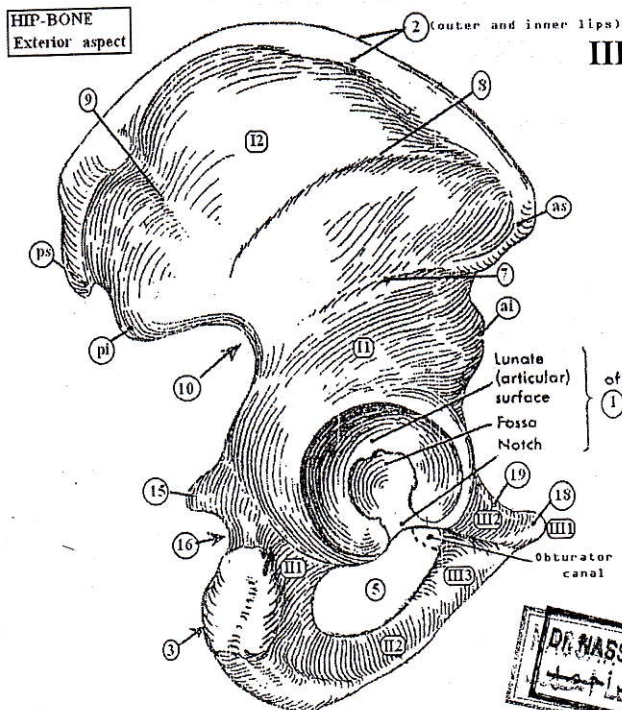
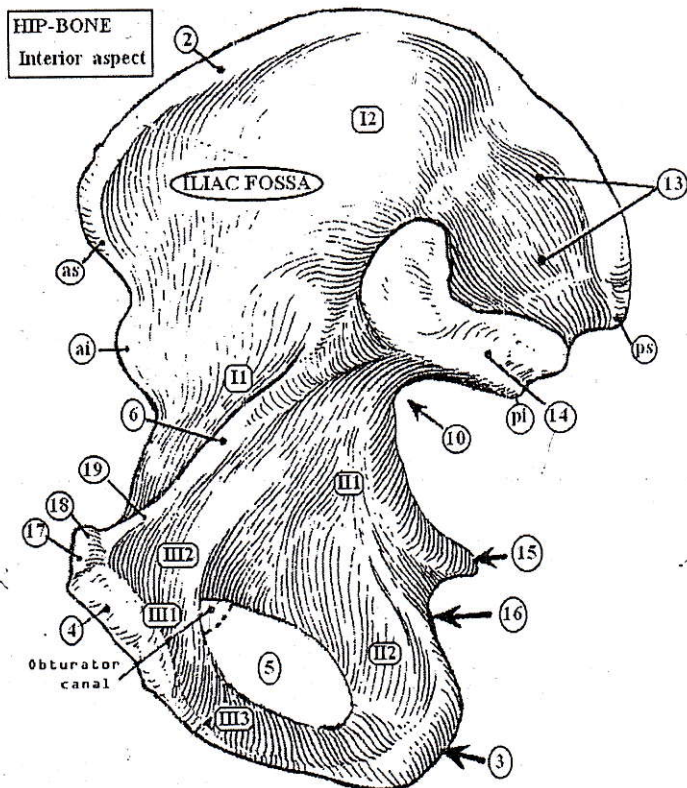
In the anterior margin of the ilium we find the **anterior-superior** (as) and the **anterior-inferior** (ai) **iliac spines**. In the posterior margin, we find the **posterior-superior** (ps) and the **posterior-inferior** (pi) **iliac spines**, and below them, the **greater sciatic notch** (10).

At the posterior part of the inner surfaces of the ilium, we find the **iliac tuberosity (13)**, and below it, the **auricular (articular) surface (14)** for the homonymous surfaces of the sacrum.

II. Ischium: it is described as formed by two portions:

1. **Body:** posterior portion. Here we can distinguish: **ischial spine (15)**, **lesser sciatic notch (16)** and **ischial tuberosity (3)**.
2. **Ramus:** it is directed medially, forwards and upwards from the ischial tuberosity, continuing with the inferior ramus of pubis to form the so-called **ischiopubic ramus**.

The **ischial tuberosity** is an important bony structure. Its lateral area provides attachments for adductor and posterior muscles of the thigh, while the medial area is the support of the body in the sitting posture.



III. Pubis: It comprises three portions:

1. **Body:** The anterior portion. Its medial surface joins by a fibrous cartilage with the opposite one forming the **symphysis pubis (4)**. The upper surface shows two elevations: the **pubic crest (17)** and the **pubic tubercle (18)**, which are important bony landmarks.
2. **Superior ramus:** it extends horizontally from the body of pubis to the iliopubic junction. Its upper surface shows a sharp edge called **pectin pubic (19)**.

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3. **Inferior ramus:** it extends obliquely from the body to continue with the ramus of ischium, forming **the ischiopubic ramus**. The two ischiopubic rami of both sides converge and meet at the lower end of the symphysis pubis forming **the pubic (sub-pubic) arch** (or angle), which is an important sexual characteristic of the pelvis.

THE SKELETON OF THE PELVIS (Bony pelvis)

The pelvis is the inferior compartment of abdominal cavity. Its skeleton is named **bony pelvis** or simply, **the pelvis**. The two **hipbones**, the **sacrum** and the **coccyx** form it. Pelvis means "a basin". The hipbones of both sides join to one another anteriorly by the **symphysis pubis**, and posteriorly they join to the sacrum by **the sacroiliac joint**. All of them are bounded together by ligaments.

Functions of the bony pelvis

1. To provide a base for attachment of the lower limbs and muscles of the trunk.
2. To transmit the weight of the body from the vertebral column to the femur (lower limbs).
3. To contain, support and protect the pelvic viscera.
4. Housing fetus during pregnancy and delivery canal.



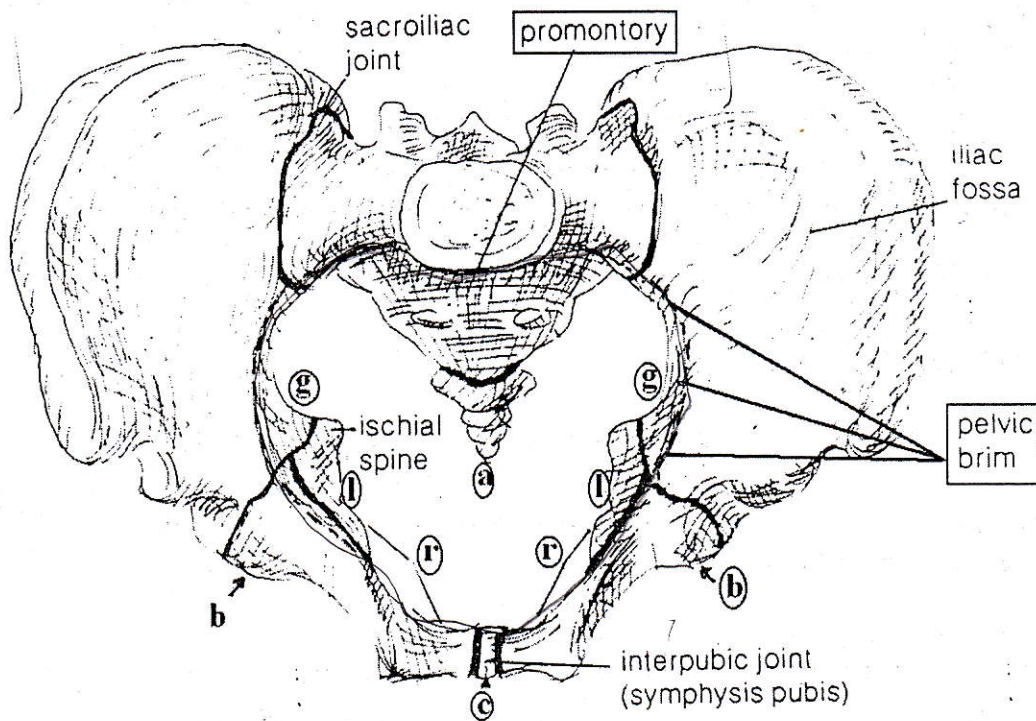
In the bony pelvis, we identify two portions: **the greater (false) pelvis** superiorly, and the **lesser (true) pelvis** inferiorly. These two portions are limited by the rounded **pelvic brim** or **pelvic inlet**, formed by **the linea terminalis** of each hipbone. The linea terminalis itself is formed by (in order from behind forwards):

1. Posteriorly, the sacral promontory and anterior margin of the ala.
2. Laterally, the arcuate line and pectin.
3. Anteriorly, the pubic crest.

The inferior aperture of the lesser pelvis or **pelvic outlet** is rhomboidal or diamond-shaped aperture closed in the living subject by the muscular floor of the pelvis (muscles of perineum). It is bounded and formed by four points and two limbs as follows:

- Posterior point → the tip of coccyx (**a**).
- Posterior limb → greater (**g**) and lesser (**l**) sciatic notch, divided by the **ischial spine**.
- Lateral points → the ischial tuberosities (right and left) (**b**).
- Anterior limb → ischiopubis ramus (**r**).
- Anterior point → pubic symphysis (inferior margin) (**c**).

→ See following picture



In the living subject, the posterior limbs are not rigid, but overlaid by the sacro-tuberous and sacrospinous ligaments that convert the sciatic notches into foramina (greater sciatic and lesser sciatic foramina).

A transverse line passing between both ischial tuberosities (bituberous diameter) divides the pelvic outlet into an anterior and a posterior triangle.

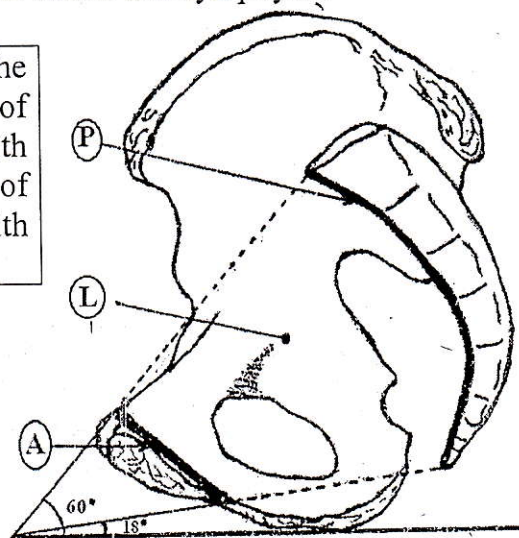


Walls of the true pelvic cavity

- Posterior: anterior (pelvic) surface of sacrum and coccyx.
- Lateral: inner surface of hipbones below the arcuate line.
- Anterior: inner surfaces of pubic bodies and symphysis.

Orientation of the pelvis: in the anatomical position, the plane of pelvic inlet is at an angle of 60° with the horizontal plane, while the plane of pelvic outlet is at an angle of 15° with the horizontal plane.

These planes and others, as well as many measurements of the pelvis are used in Gynecology-Obstetric practice.



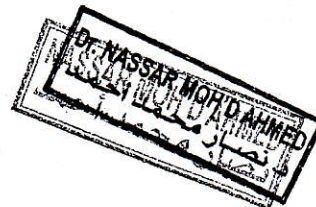
Sex differences of the bony pelvis

Differences are linked to function. While primary pelvic function in both sexes is locomotor, the pelvis is adapted to childbearing and parturition in female, particularly the lesser pelvis. Such condition affects proportions and dimensions of the whole bony pelvis. These distinctive sex characters are already present in the fetal pelvis by the third or fourth month of intrauterine life (I.U.). They are poorly marked in childhood but become fully developed after puberty.

1. Since males are distinctly more muscular and therefore more heavily built, overall pelvic dimensions are greater, marking for muscles and ligaments more pronounced, and general bony architecture heavier.
2. Pelvic cavity in females is wider, shorter and rounded. In males it is long, narrower and funnel-shaped. (These conditions affect mainly the diameters of the inferior aperture of outlet).
3. In females the superior aperture (inlet) is larger and kidney-shaped, forming a greater angle with the horizontal plane (more tilted forwards). In males it is smaller, heart-shaped and more horizontal.
4. In females the pubic arch is wider with a round apex. In males, the angle is narrow, less than 90° .
5. In females the greater sciatic notch is wider (about 90°). In males its outline is U-shaped.

Other peculiarities of the female pelvis are:

- Ala of ilium more expanded or everted.
- Iliac fossa shallower.
- Sacral promontory projects less forwards.
- Sacrum shorter and wider.
- Coccyx more movable.
- Pubic tubercles wider apart.
- Ischial spine less interned.
- Obturator foramen smaller and triangular-shaped.
- Acetabula further apart and smaller.



It is difficult to find samples that are 'female' in all respects. Pelvis are often intermediate in many characters, or are female-type in one part but show male characters elsewhere. It is advisable to know the type of pelvis to value the significance and expectancy of particular features in obstetrics. As general principle, all the already mentioned features contribute to adapt female pelvis to childbearing and parturition.

PELVIC JOINTS

SACROILIAC JOINT

Classification: synovial, simple, plane and non-axial.

Articular surfaces: auricular (articular) surfaces of the sacrum and the hipbone.

Ligaments:

Main ligaments:

1. Ventral (anterior) sacroiliac
2. Dorsal (posterior) sacroiliac
3. Interosseous sacroiliac

Accessory ligaments:

4. Sacrospinous
5. Sacrotuberous

Movements: only little antero-posterior rotation around the transverse axis. It increases during pregnancy and at parturition. (Some translation or gliding is associated to rotation).

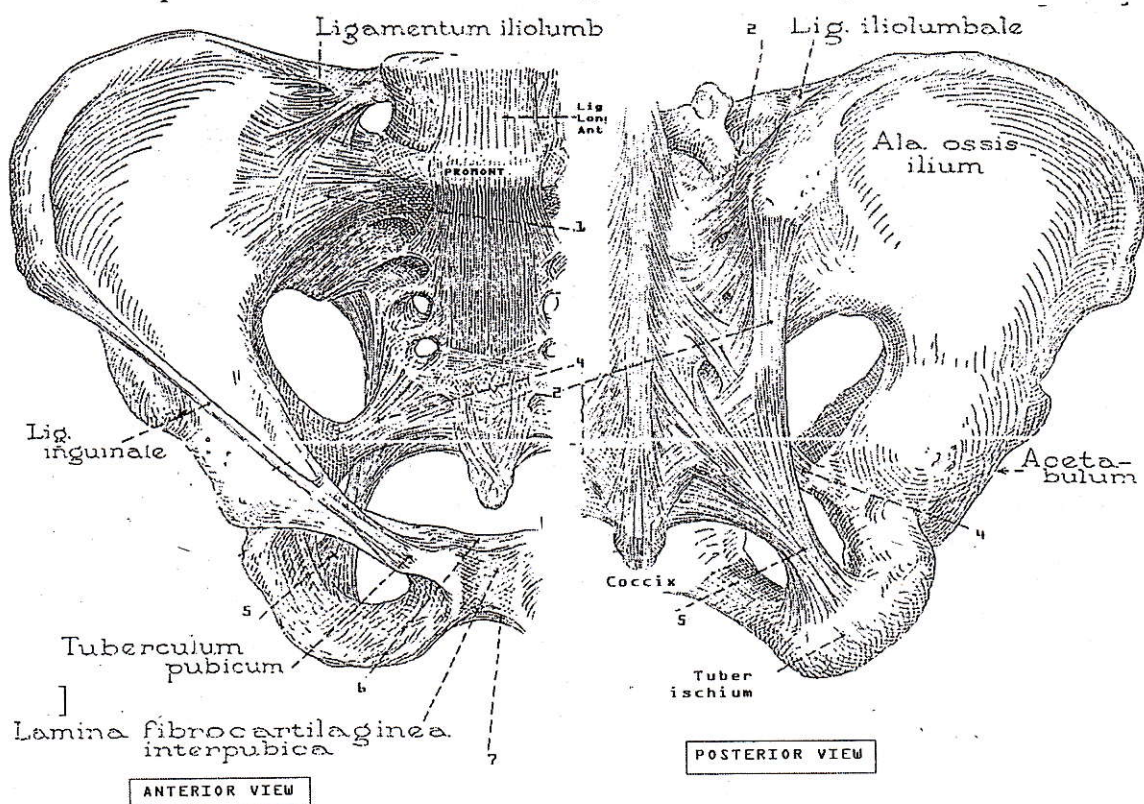
SYMPHYSIS PUBIS

Classification: secondary cartilaginous or symphysis type. The interpubic fibro cartilaginous disc often contains a cavity, non synovial (like a fissure), better developed in females.

Articular surfaces: the two-symphysial surfaces of the pubic bodies.

Ligaments: superior pubic (6), arcuate pubic (7) and anterior interlacing fibers.

Movements: slight angulation, rotation and displacement are possible. Some separation is held to occur late in gestation and during childbirth.



CLINICAL ANATOMY

During pregnancy the pelvic joints and ligaments relax, while movements increase. Relaxation renders the sacro-iliac 'locking' mechanism less effective, permitting greater rotation and perhaps allowing alterations in pelvic diameters at childbirth. Such impairment produces frequent sacro-iliac strains after pregnancy. After childbirth the ligaments tighten and the 'locking' mechanism improves, but this may occur in a position adopted during pregnancy. Such sacro-iliac 'subluxation' causes pain by unusual ligamentous tension; reduction by forcible manipulation may be attempted. The most common position in this condition of subluxation is believed to be backwards rotation of the hipbone relative to the sacrum: usually unilateral, sometimes bilateral.

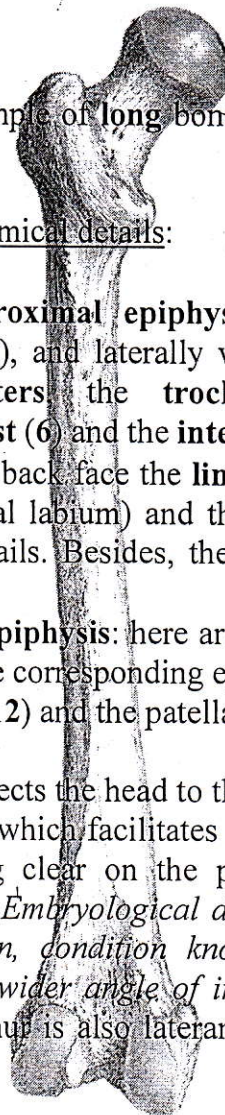
FEMUR

It is the longest typical example of long bone in the skeleton, placed at the thigh.

Portions and important anatomical details:

- **Proximal end or proximal epiphysis:** here is the **head** (1) medially; the **neck** (2), and laterally we find the **greater** (3) and **lesser** (4) **trochanters**, the **trochanteric fossa** (5), the **intertrochanteric crest** (6) and the **intertrochanteric line** (7).
- **Body or shaft:** in the back face the **linea aspera** (8) showing two lips (lateral and medial labium) and the **poplitea surface** (9) are the more relevant details. Besides, the **gluteal tuberosity** and the **pectineal line**.
- **Distal end or distal epiphysis:** here are the **condyles**: medial (10) and lateral (11) and the corresponding **epicondyles** (10e & 11e), the **intercondylar fossa** (12) and the **patellar surface** (13).

The **neck of the femur** connects the head to the shaft at an angle of about 125° -**angle of inclination**-, which facilitates movements at the hip joint, enabling the limb to swing clear on the pelvis. *This angle changes (reduces) according to age. Embryological disturbances may produce a smaller angle of inclination, condition known as "coxa vara". The opposite condition (that is: wider angle of inclination) is named "coxa valga".* The neck of the femur is also laterally rotated with respect to



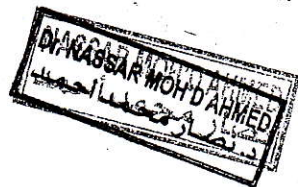
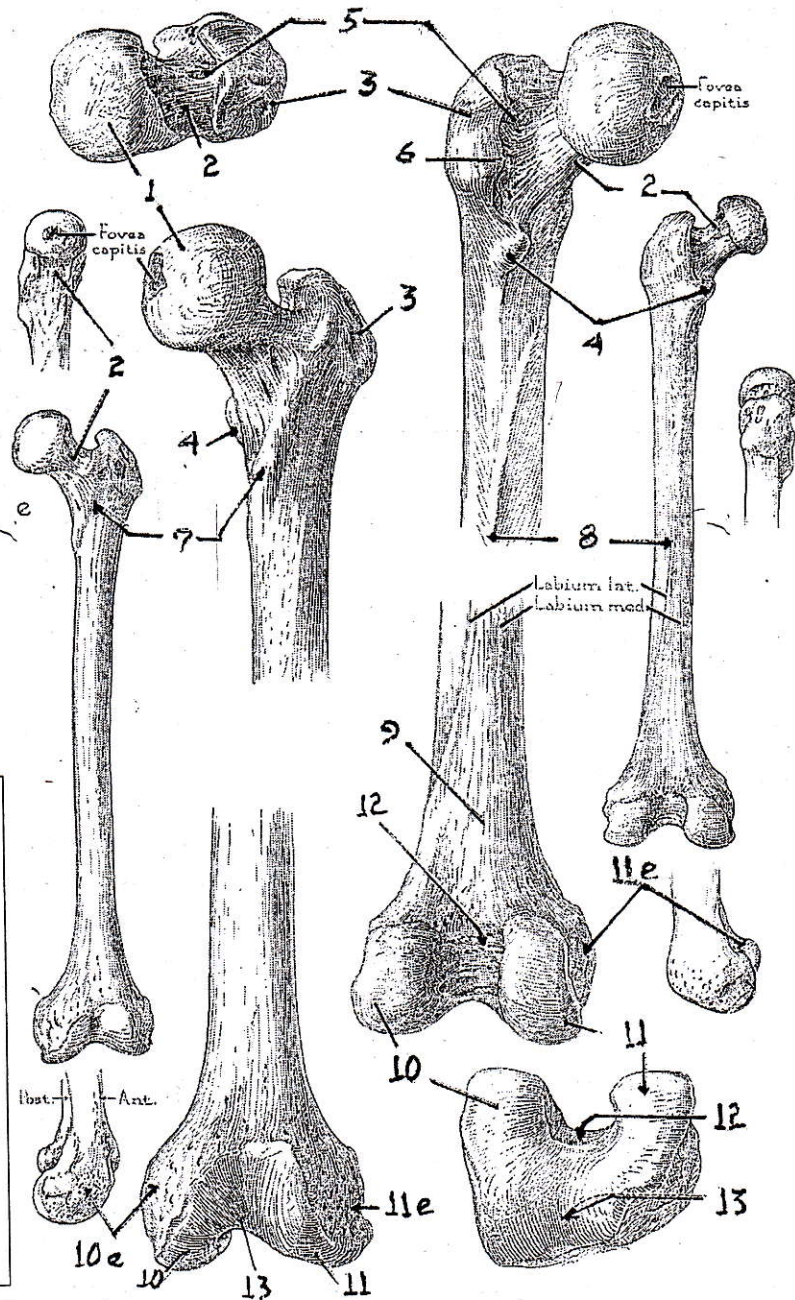
the shaft: "angle of anteversion" or "torsion angle of femur" some 10° - 15° although values as low as 7° has been reported. It allows the best position of the limb to move on the hip joint.

Anatomical position:

- The head (on the proximal end) directed upwards, medially and slightly forwards.
- The convexity of the shaft is directed forwards.
- The medial epicondyle (extended to a lower level than the lateral one) is in line with head of the bone.
- Linea aspera directed backwards.

CLINICAL ANATOMY

Fractures of the femoral neck are usually due to transmitted stress, as in tripping over obstacles. They are frequent in old people.



HIP JOINT

Classification: it is synovial, simple, complex (presence of a labrum), spheroidal (ball-and-socket) and multiaxial.

Articular surfaces: the head of the femur and the acetabulum of the hipbone. A cartilaginous ring, **the acetabular labrum** attaches to the border of the acetabulum. It deepens the cavity of the acetabulum, and contributes to grasp the head of the femur.

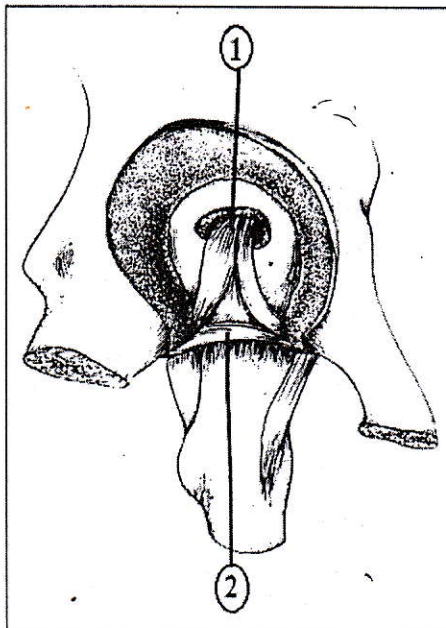
Ligaments:

Intrinsic

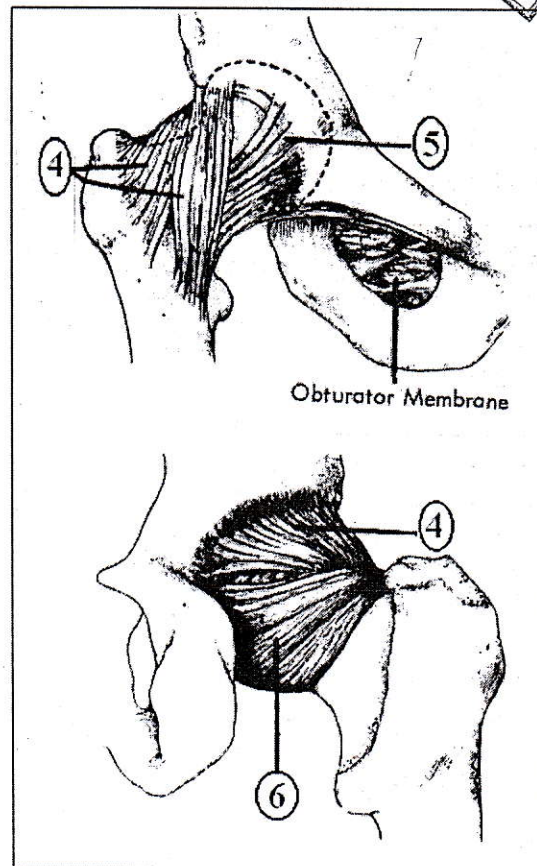
1. Lig. of the head of the femur
2. Transverse acetabular lig.

Extrinsic

4. Iliofemoral
5. Pubofemoral
6. Ischiofemoral



- Abduction-adduction
- Medial-lateral rotation
- Circumduction



Although the hip joint is an spheroidal one, its movements are much more limited in comparison to the shoulder joint, because the head of the femur is closely fitted to the acetabulum, embraced more closely by its labrum.

CLINICAL ANATOMY

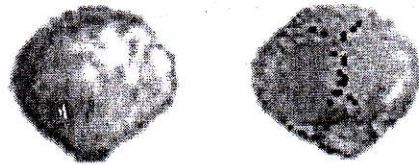
Congenital dislocation is common at the hip joint than elsewhere.

PATELLA

Classification: it is a short bone, the largest of the sesamoid bones (about 5 cm in diameter), set in the tendon of quadriceps femoris muscle.

Portions and anatomical position:

- The **apex (1)** downwards and the **base (2)** upwards.
- There are two surfaces: **anterior surface (A)** and **articular facet, backwards (P)**.
- The medial articular (**m**) facet is the smallest one.

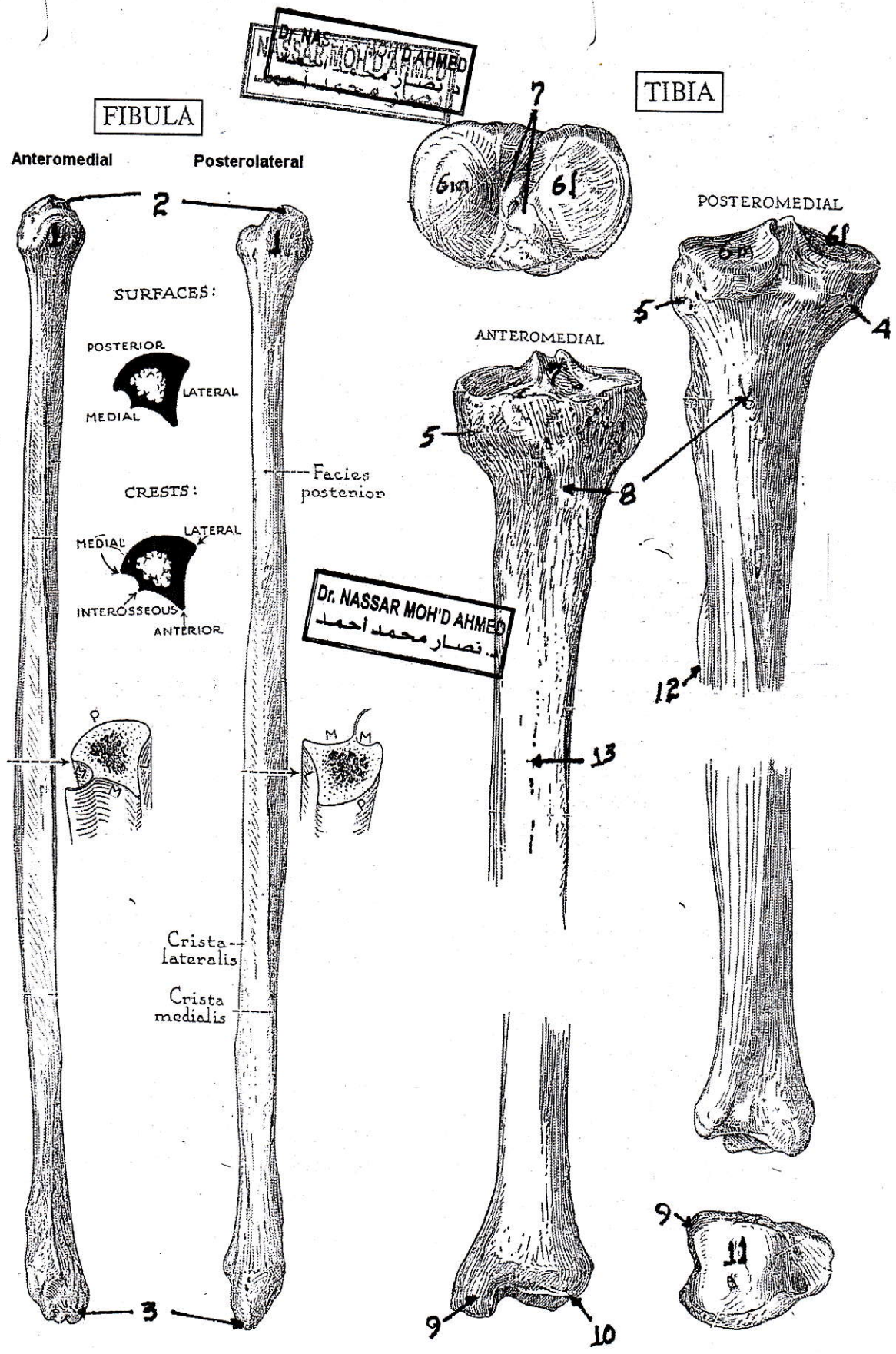


TIBIA AND FIBULA

Classification: they are typical examples of long bones placed and joined parallel to one another at the leg.

Anatomical position: first of all, remember that the tibia is placed at the medial side of the leg, while the fibula is placed laterally.

Tibia	Fibula
• Larger epiphysis is proximal. It shows two condyles: lateral (4) and medial (5) with the articular surfaces (6) and inter-condylar crests (7).	• The proximal end or head (1) is expanded provided by an apex (2).
• Tuberosity (8) of tibia forwards.	• The lateral malleolus (3) in the distal end is oval-shaped.
• In the distal epiphysis medial malleolus (9) is to the medial side and fibular notch (10) lateralwards. There is an articular surface (11) for the talus	• And the malleolar fossa is <u>backwards</u> to the malleolus.
• The body is very strong and shows 3 surfaces and 3 borders: the lateral (12) is interosseous and the anterior (13) is palpable.	• The body is twisted, thin, with 3 surfaces and 4 borders or crests. The interosseous crest is medial-wards.



KNEE JOINT

Classification: it is a typical synovial joint, condyloid, compound, and complex owing to the presence of two menisci: lateral (LM) and medial (MM). Functionally it is biaxial because it allows movements in two axes: around the transverse axis flexion-extension and with the leg in partial flexion it is possible some medial and lateral rotation around the vertical axis.

Articular surfaces: the condyles of femur, the corresponding articular surfaces of the condyles of tibia and the articular facets of patella.

Main Ligaments:

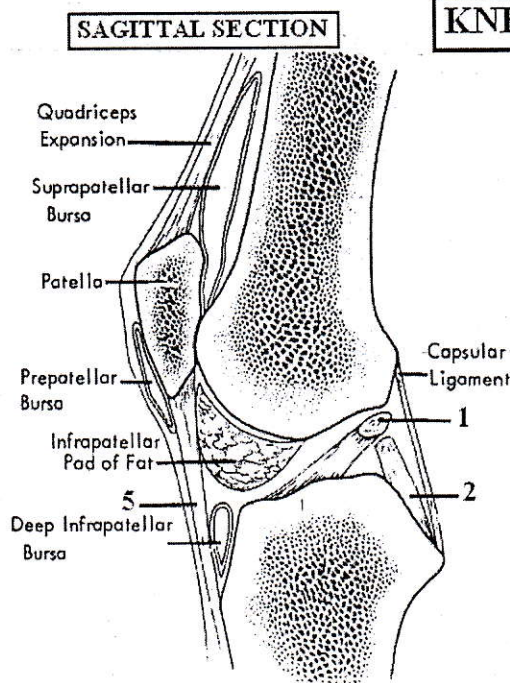
Intra-articular ligaments

1. Anterior cruciate lig.
2. Posterior cruciate lig.

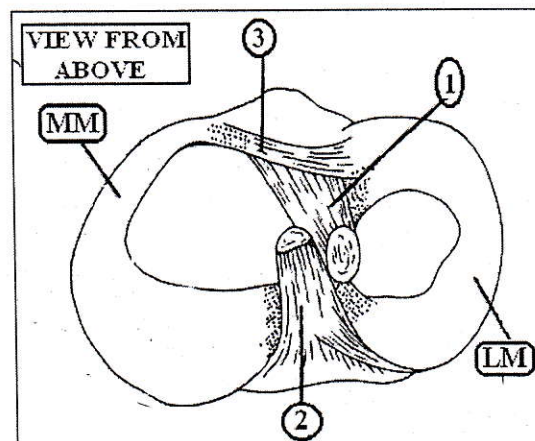
Extra-articular ligaments

3. Transverse lig.
4. Collateral ligg. (fibular and tibial)
5. Patellar lig.
6. Popliteal ligg (oblique and arcuate)

They are described some synovial **bursae**, which names is according to the situation: supra-patellar, pre-patellar and infra-patellar. They are very important to cushion the movements of the patella and the patellar tendon. Also it is found some **pads of fat**. As you can see, this joint is very complex due to the functions it has to fulfill and its disturbances are very frequently.



KNEE JOINT



المفصل المرن
بالمفصل المرن
Compound

ANKLE (Talocrural) JOINT

Classification: it is synovial, compound, hinge (or trochlear), uniaxial.

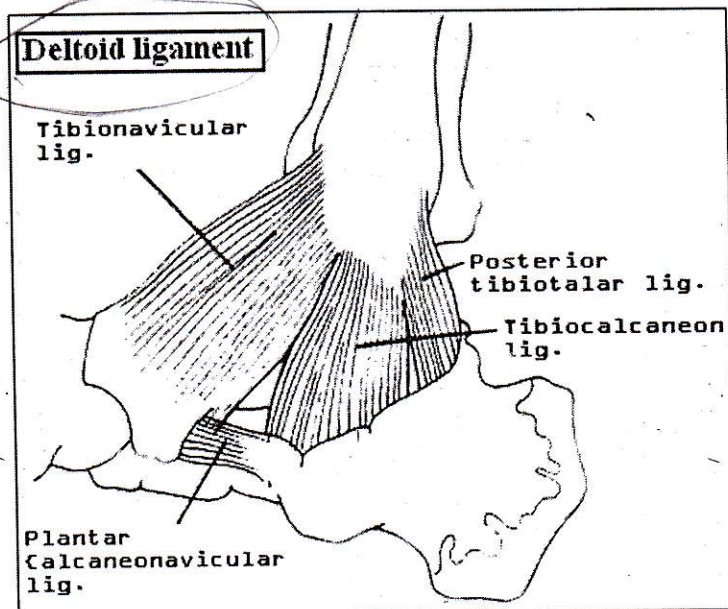
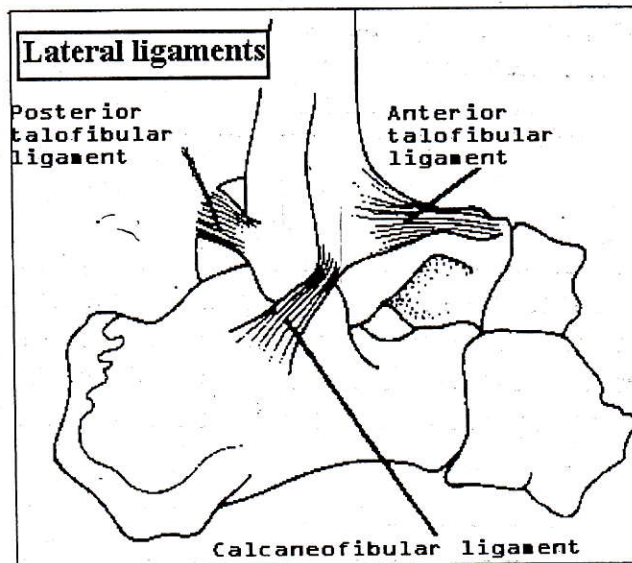
Articular surfaces: the distal ends of the tibia and fibula, forming a "socket" where the upper portion of talus (trochlea) rocks around a transversal axis

Movements: dorsiflexion and plantar flexion.

→ When foot is in plantar flexion position, it allows movements of side-to side gliding, rotation and eversion-inversion with the participation of the sub-talar joints.

Main Ligaments:

- Deltoid (medial) lig.
- Anterior talo-fibular lig.
- Posterior talo-fibular lig.
- Calcaneo-fibular lig.



all the joint
below
"eversion
inversion"

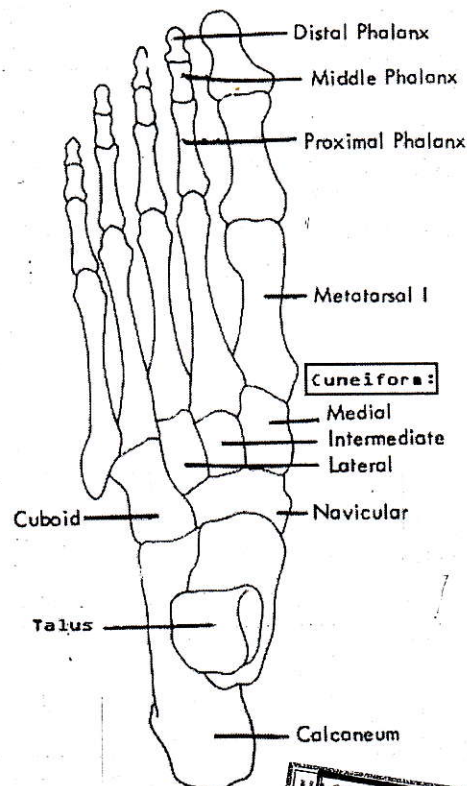
THE FOOT

The foot is the distal portion of the lower limb. It comprises a solid postero-superior segment or **tarsus**, formed by seven (7) short bones, a middle segment or **metatarsus**, formed by five (5) miniature long **metatarsal bones** and the distal segment formed by the **phalanges of the toes**.

Bones of the tarsus:

- In the proximal row: talus and calcaneus bones.
- In the distal row: navicular bone, cuboid bone (laterally) and cuneiform bones (lateral, intermediate and medial).

Metatarsus and phalanges bones are enumerated from the big toe (medially) to lateral side: I to V.



The foot has two major functions:

- To support the body in standing and progression.
- To lever the body forwards in walking, running and jumping.

Anatomical position:

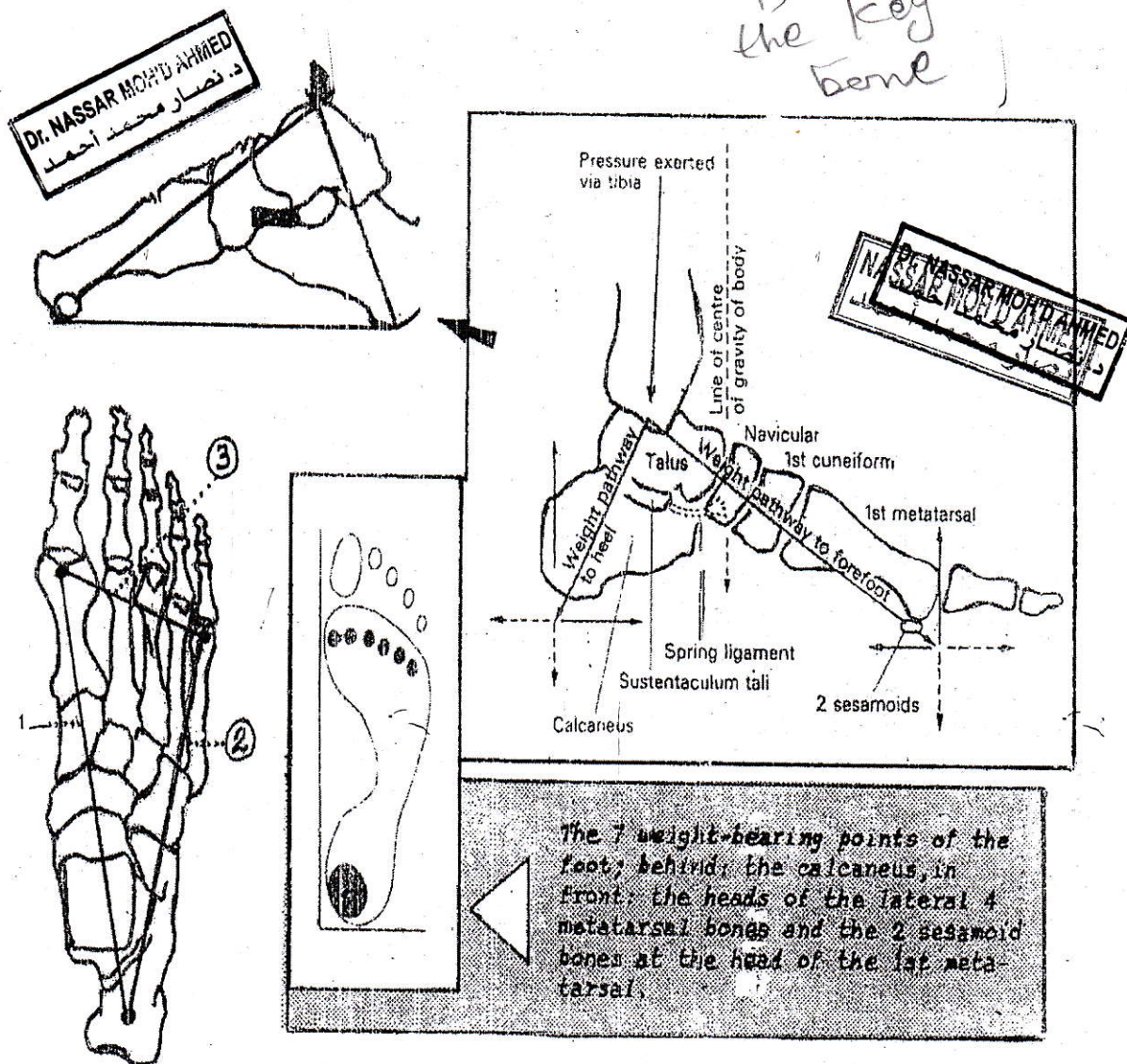
- Arched (concave) plantar side, downwards on the floor.
- Talus bone upwards.
- Calcaneus bone backwards.
- Big toe to the medial side of the foot.

FOOT AS a WHOLE

The weight-bearing (supporting) function of the foot is achieved by the arched structure of its skeleton. Three plantar arches are formed:

1. Medial longitudinal arch: calcaneus, talus, navicular, the three cuneiforms and the three medial metatarsals (I, II and III).
2. Lateral longitudinal arch: calcaneus, cuboid, and the two lateral metatarsals (IV, V).
3. Transverse or metatarsal arch: the metatarsal bones and the distal row of tarsal bones (the three cuneiforms and cuboid).

Calcaneus
is
the key
bone



Factor helping to maintain the arches of the foot

1. Configuration (shape) of the articular surfaces. The shape and position of the talus as a "key-stone".
2. Plantar ligaments.
3. Plantar aponeurosis connecting the anterior and posterior ends of the longitudinal arches as a "tie-beam".
4. Muscles and tendons running longitudinally on the plantar aspect of the foot.

CLINICAL ANATOMY

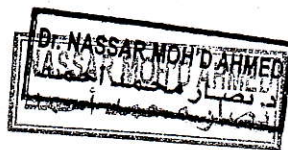
Flattening of the arches of the foot is a condition known as "**flat foot**" or "**pes planus**". The opposite condition (that is when the arches are too marked) is named "**pes cavus**". Between these two extreme conditions there is a wide range of situations.

THE TRANSMISSION OF THE WEIGH OF THE BODY

- The weight of the body is carried from the vertebrae to the sacrum. From the sacrum a half of the body weight is transmitted to each sacro-iliac joint.
- In the standing position the body-weight is transmitted from the sacro-iliac joints to the hip joints; then to the femurs. Because the femurs lie obliquely, the 'lateral' femoral condyles receive most of the weight.
- The tibia alone receives the body-weight from the femur and transmits it to the talus. This means that in the standing position a half of the weight of the body is borne by each talus.
- The talus then transmits a half of this weight backwards through the calcaneus to the heel while the other half is transmitted from the talus forwards to be distributed equally to six (6) bearing points in front; which are the heads of the lateral four metatarsal bones and the two sesamoid bones at the head of the first metatarsal.
- In the sitting position the body-weight is transmitted from the sacro-iliac joints to the ischial tuberosities.

CLINICAL ANATOMY

- *In the normal conditions, the vertical bearing axis of the lower limb extends straightly passing through the hip joint, to the knee joint, then to the ankle joint. This condition is known as 'genu rectum'.*
- *The leg may be abnormally abducted, 'genu valgum' or 'knock knee'. Or abnormally adducted, 'genu varum' or 'bow knee'.*
- *The defect may be appear to be in the knee joint, but usually the entire length of the femur and tibia is involved with abnormalities of growth occurring at the epiphysial plates if the bones are immature or due to rickets or bad posture.*



GUIDE FOR PRACTICE CLASS # 6

Theme: SKELETON OF THE LOWER LIMB

Summary:

- Bones of the lower limb.
- Joints of the lower limb.
- Surface and radiological anatomy.

Objectives:

1. To identify in the human skeleton the bones and joints of the lower limb.
2. To describe the particular characteristics of the bones and main joints of this skeleton region, identifying them in the already prepared anatomical pieces.
3. To identify the most relevant bony features in the body surface and by radiographs.



Methodological orientations (TASKS)

Follow the general orientations about osteology and sindesmology in order to point out the general characteristics of the required bones and joints.

1. Identify the bones of the lower limb in an articulated skeleton.
 - Use Atlas or chart.
2. In a group of bones, identify the hip, femur, patella, tibia and fibula and describe their particular characteristics. Use Atlas: figures 151 to 169.
 - Some considerations should be taken into account in order to put each bone in the anatomical position.
3. Identify in the articulated skeleton of the **foot**, the regional division and the bones that each region.
 - It is important to precise the names and number of the bones that form each region, proceeding from medial.
 - Utilize Atlas: figures 170 to 172, 246 to 253 and the figures of your textbook.
 - Indicate the plantar arches, the bony structure of arches, factors maintaining those arches and its importance.
4. Indicate in the skeleton and / or in the Atlas' figures the joints of the lower limb: sacroiliac, hip, symphysis pubis, knee, tibio-fibular, ankle and joints of foot.

- Classify them.
- Do the movements that take place at these joints, mentioning the axis of these movements.
- Describe the particular characteristics of the greater joints (the underlined).
- Utilize Atlas: figures 224 to 246 of the Atlas.



5. Identify the bony component of the pelvis and describe its general aspects.
 - It is important to precise the division of the pelvis, limits and the structures of its walls (figures 224 to 231).
 - Mention the sexual differences (figures 224 to 225).
 - Revise the pelvis measurements (figures 147, 148 and 231).
6. **Surface anatomy:** identify the more distinct bony features on the skin surface of the upper limb:
 - On the anterior aspect of the pelvic region, palpate the iliac crest, anterior superior iliac spine.
 - On the posterior aspect observe a small depression in which is indicated the posterior superior iliac spine (at the level of the second sacral vertebra).
 - Flex the lower limb at the hip joint in order to palpate the ischium tuberosity from inferior gluteal view.
 - On the lateral aspect of the pelvis, it can be palpated the greater trochanter of the femur.
 - In the knee joint it can be palpated the distal extremity of the femur and also the patella.
7. **Radiology anatomy:** indicate the possible visible bony features in x-rays planes of the lower limb. Use Atlas' figures.
 - In a frontal view of a radiograph of the pelvis it is observed the bony components of it and the proximal extremity of the femur. Identify the important anatomical structures seen in this view.
 - In a frontal view of the hip joint it is possible to indicate the bones forming the joint, head and neck of the femur and the acetabular cavity. Also the greater and lesser trochanter of the femur.
 - In a lateral view of the knee region it can be seen the distal extremity of the femur and the patella.

Bibliography:

- Cunningham's textbook of Anatomy. Pages 174 to 208 and 242 to 262.

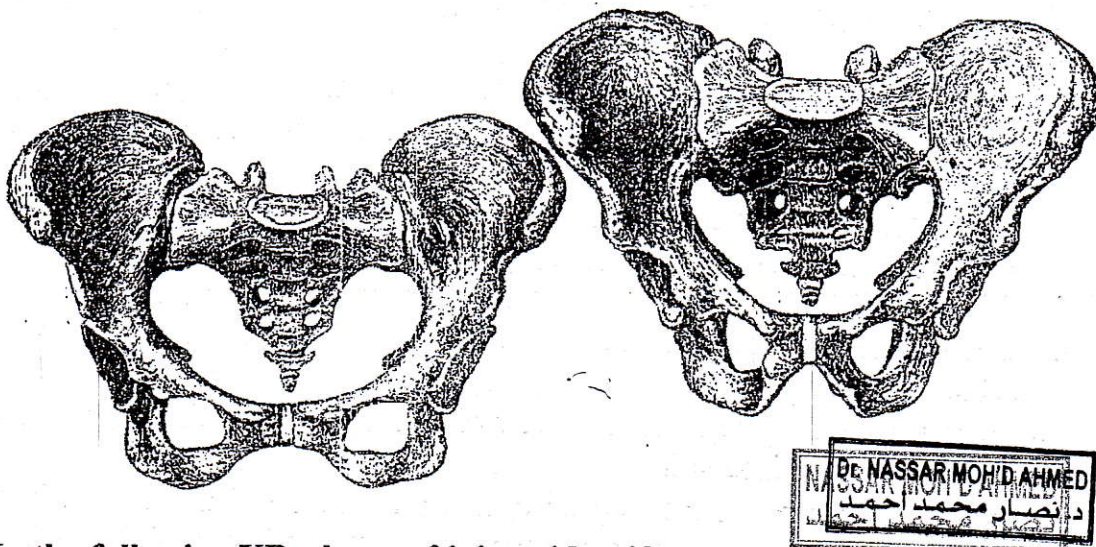
- Sobotta/Figge Atlas of Human Anatomy. Pages 78 to 92 and 118 to 137
- You may use the learning guide to Practical Anatomy I' booklet. Pages 38 to 47.

SELF-ASSESSMENT ACTIVITIES

1. Identify which picture correspond to each sex and give reasons.

A _____

B _____



2. In the following XR-planes of joints, identify:

Name _____

Name _____

View _____

View _____

Side _____

Side _____

